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BYTE

NOVEMBER 1993

THE WORLDWIDE COMPUTING AUTHORITY

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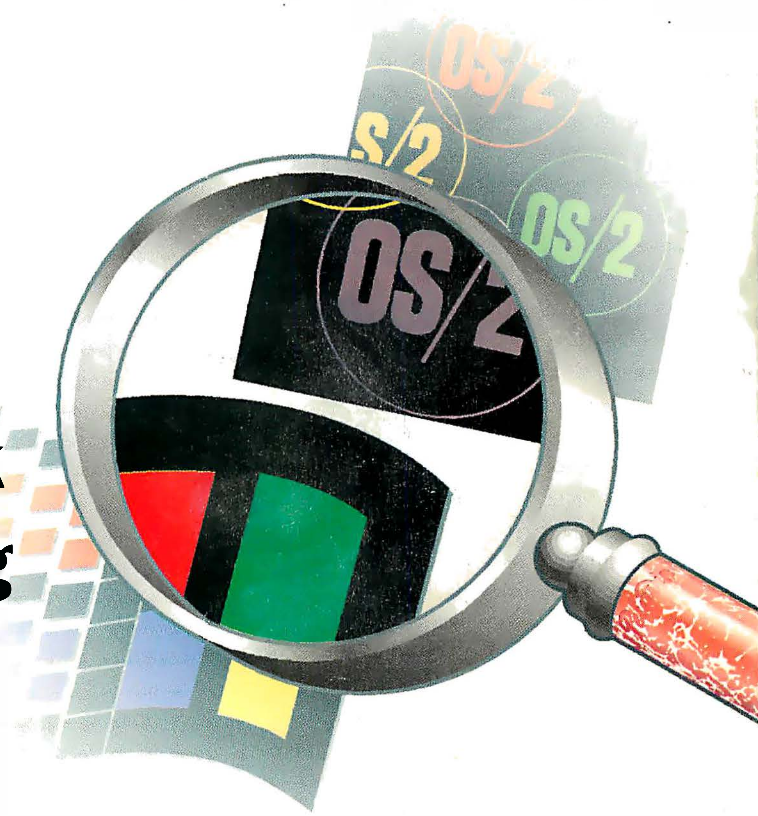
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SPECIAL REPORT

Windows vs. OS/2

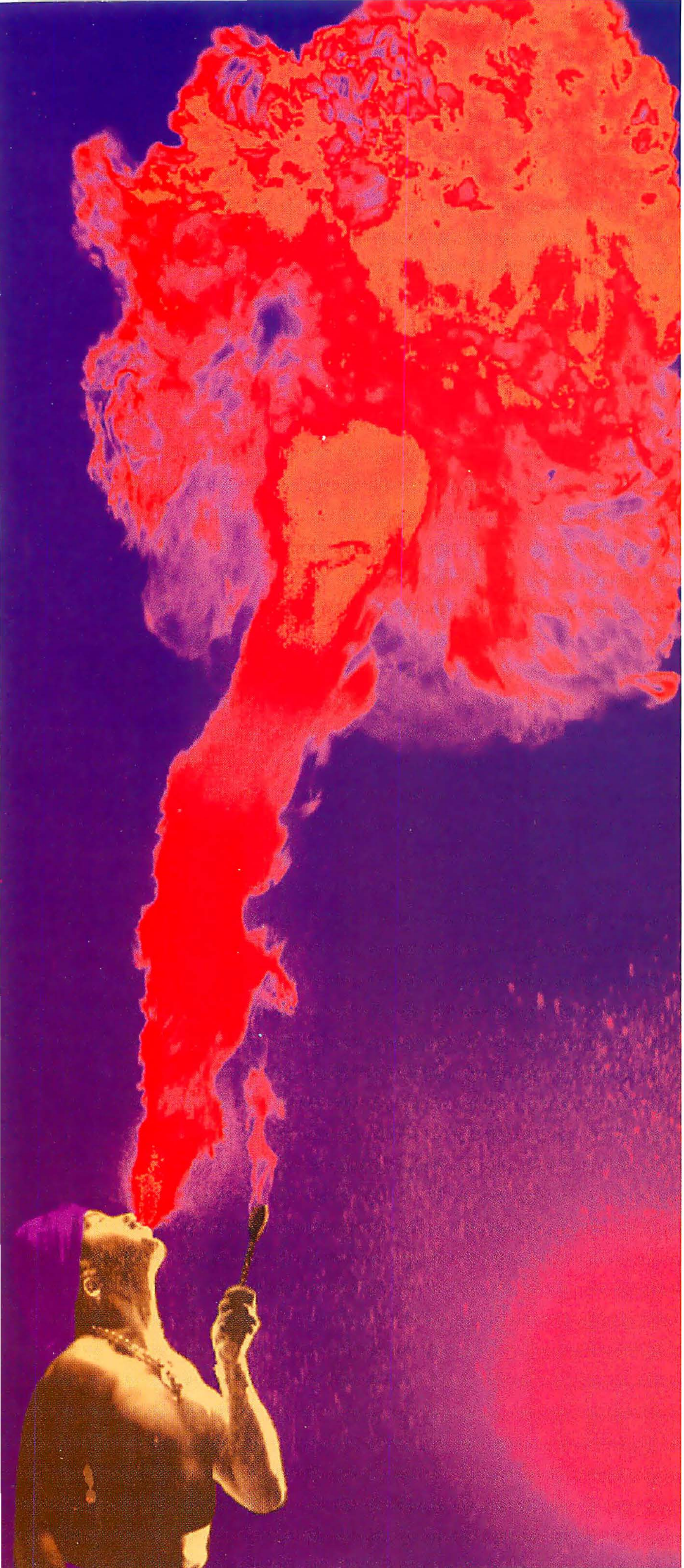
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- 101-Key Keyboard
- Microsoft Mouse
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- Choice of Application Software
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- 14" Color CrystalScan 1024NI
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- 124-Key AnyKey Keyboard
- Microsoft Mouse
- MS-DOS, Windows & Tools
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- Microsoft Mouse
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P5-60 Best Buy

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- 3.5" Diskette Drive & 2X CD-ROM
- 424MB 13ms IDE Hard Drive
- PCI ATI Ultra XLR 2MB Graphics
- 14" Color CrystalScan 1572FS
- New 300W Tower Case
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- 124-Key AnyKey Keyboard
- Microsoft Mouse
- MS-DOS, Windows & Tools
- MS Works for Windows 2.0

$2995

P5-60

- Intel 60MHz **Pentium**™ Processor
- 16MB RAM, 256KB Cache
- 3.5" Diskette Drive & 2X CD-ROM
- 528MB 12ms IDE Hard Drive
- PCI ATI Ultra XLR 2MB Graphics
- 17" Color Crystal Scan 1776FS
- New 300W Tower Case
- 4 ISA, 2 PCI & 1 PCI/ISA Slots
- 124-Key AnyKey Keyboard
- Microsoft Mouse
- MS-DOS, Windows & Tools
- Choice of Application Software

$3995

Software Choices

If a system comes with "choice of application software," choose one of the following packages:

- Microsoft Excel for Windows™
- Microsoft Word for Windows™
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DOES...TOCK

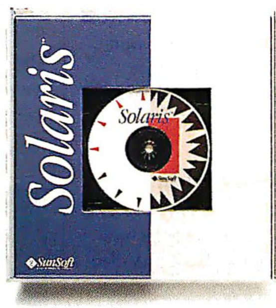
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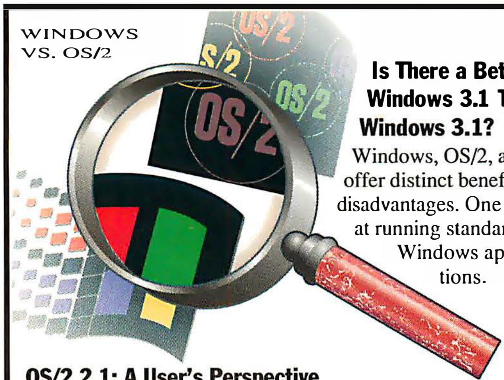
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News & Views

Special Report

WINDOWS VS. OS/2

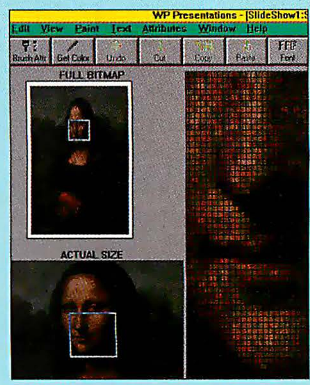


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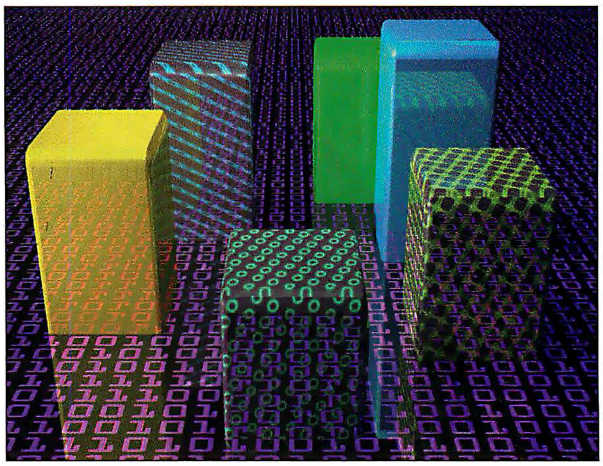


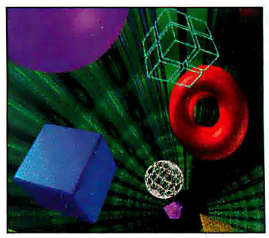
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State of the Art







Opinions

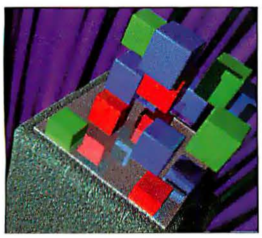
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From BIX: Join "listings/frombyte93" and select the appropriate subarea (i.e., "nov93").

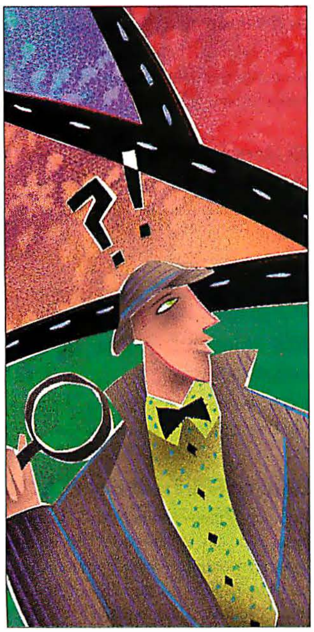
From the UUNET:ftp to ftp. uu.net, log on as "anonymous," and enter your user ID as your password. Type "cd/published/byte" and type "DIR." Files appear in subdirectories arranged by month.

From the BYTE BBS at 1200-9600 bps: Dial (603) 924-9820 and follow the instructions at the prompt.

BYTE (ISSN 0360-5280) is published monthly with additional issues in April and October by McGraw-Hill, Inc. U.S. subscriber rate $29.95 per year. In Canada and Mexico, $34.95 per year. European surface mail subscriptions $60, airmail $80. Non-European subscriptions, $60 surface mail or $85 airmail. All foreign subscriptions are payable in U.S. funds that can be drawn on a U.S. bank. Single copies $3.50 in the U.S., $4.50 in Canada. Executive, Editorial, Circulation, and Advertising Offices: One Phoenix Mill Lane, Peterborough, NH 03458. Second-class postage paid at Peterborough, NH, and additional mailing offices. Postage paid at Winnipeg, Manitoba. Registration number 9321. Registered for GST as McGraw-Hill, Inc., GST #123075673. Printed in the United States of America. Postmaster: Send address changes and fulfillment questions to BYTE Subscriptions, P.O. Box 552, Hightstown, NJ 08520.



Hands On



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BYTE Contents by Platform

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It's The Ultimate In Storage!



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19 msec effective access time

2.0 MBytes per sec. data throughput

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Introducing the Sierra™ 1.3 Gigabyte optical hard drive with speeds faster than most magnetic hard drives and removable media for infinite capacity. With each additional standard optical disk you'll have another 1.3 Gigabytes of capacity to store spreadsheets, databases, CAD/CAM, graphics, multimedia or any data intensive application demanding mountains of storage.

The Sierra™ 1.3 GB is a lightning fast mass storage system with performance that rockets past most magnetic hard disk drives. (see chart)

OPTICAL PERFORMANCE ADVANTAGE

	XCOPY 20MB TO OPTICAL DRIVE/HARD DRIVE	XCOPY 50MB TO OPTICAL DRIVE/HARD DRIVE
PINNACLE SIERRA™ 1.3GB	135.3 seconds	379.5 seconds
SEAGATE ST4766N (630MB)	210.6 seconds	496.8 seconds
FUJITSU M2266SA (1.2GB)	165.5 seconds	375.1 seconds
MAXTOR XT-8760SH (676MB)	178.9 seconds	428.7 seconds

Optical technology has many advantages such as removability, reliability, expandability, and is less expensive than magnetic storage solutions.

OPTICAL PRICE ADVANTAGE

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"It has a 19 millisecond access time and outperformed every other device we tested here." Stanley Wszola, *Byte*

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Pricing acquired directly from System Integrators on 9/15/93. Avg. hard drive cost $2.50 per Megabyte. Tests performed by NSTL.

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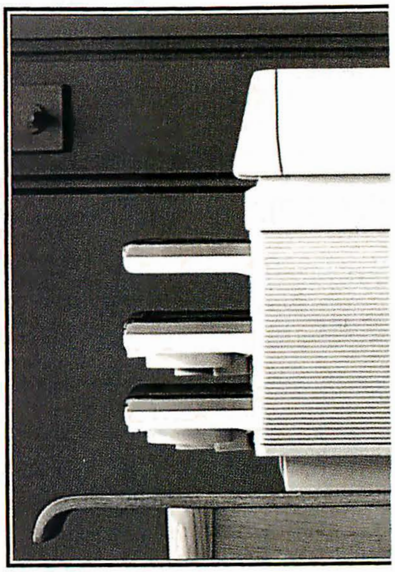
THIS SHOULD GIVE YOU
OF WHY WE CREATED AN

The image you see over there started out attached to the image you see over here. But as it made its way to the printer, the computer it was created on recognized a problem: 11 x 17 pages can't fit on 8 ½ x 11 paper.

And so, out came the electronic scissors.

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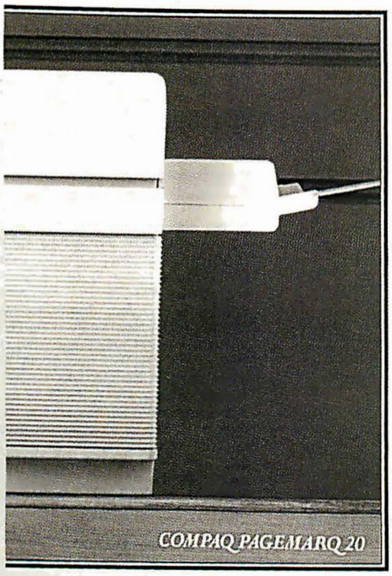
trays, which lets you switch between paper sizes without leaving your desk, so you don't have to pull one paper tray out and replace it with another, only to have your neighbor

CONNECTIVITY OPTIONS

COMPAQ PAGEMARQ Printers can be directly connected into the following environments: NetWare, EtherTalk, LocalTalk, LAN Manager, LAN Server, Windows NT, and TCP/IP (including Sun, HP, SCO, IBM, DEC and lpd compatible hosts).

I A PRETTY GOOD IDEA
J 11 x 17 LASER PRINTER.

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All of which print with razor-sharp clarity thanks to the 800 x 400 dpi-high-resolution mode.

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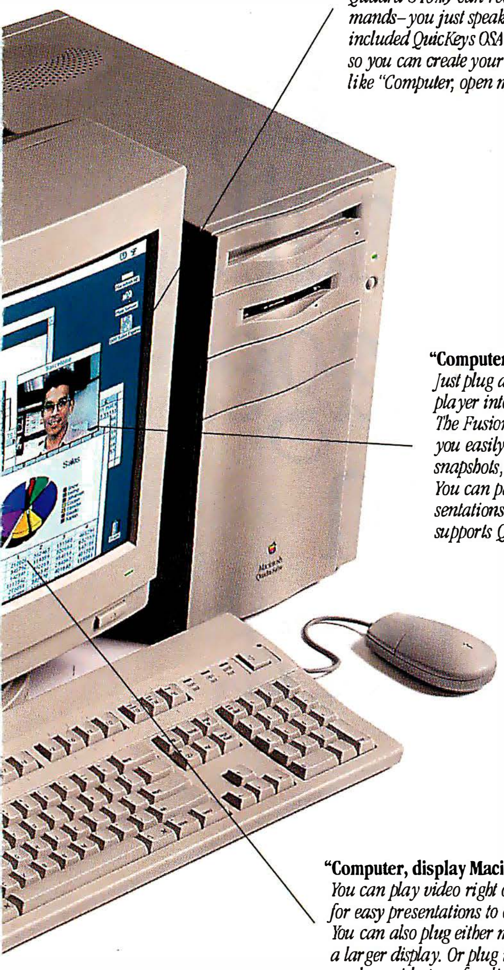
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Windows, NT, or OS/2



To pick the right operating system, you need to examine technologies and strategic directions

Both Windows NT and OS/2 run applications written for Windows 3.1, but which is best? You might expect that either 32-bit advanced operating system—NT or OS/2—would naturally be better than Windows 3.1 running on top of DOS. However, Jon Udell, one of BYTE's operating-system experts, made an interesting discovery that might surprise you (see "Is There a Better Windows 3.1 Than Windows 3.1?" on page 85).

Udell's article does more, though. It sums up the current debate about operating systems for Intel-based computers. Is upgrading to either NT or OS/2 2.1 worthwhile? That's not an easy question to answer, and it's complicated by the fact that the number of 32-bit applications that can exploit either NT or OS/2 is small compared to those made for Windows 3.1.

That's why much of the debate should also focus on what NT and OS/2 promise; therefore, you ought to examine the technologies and strategic directions of the two systems. To that end, BYTE editors have compiled articles in this issue on what we believe to be the hottest debate going.

Take, for example, distributed processing. Recently, IBM announced its Distributed Computing Environment SDK (Software Development Kit) (see "IBM Ships DCE SDK for OS/2 and Windows" on page 131). Long thought to be too complicated for microcomputers, true distributed computing will become possible on OS/2 and Windows. Meanwhile, other major players are readying their responses for distributed computing.

On a related subject, you should also examine IBM's Distributed System Object Model (see "IBM's Assault on Distributed Objects" on page 125). Now applications can reach across a network to use remote objects, which is essential for distributed processing.

Speaking of networks, Barry Nance provides some insight into the six Windows or OS/2 native-networking options (see "OS/2 and Windows Networks" on page 117). Sorting through the advantages of Windows for Workgroups, NT, Windows NT Advanced Server, LAN Server, LAN Manager, or Novell NetWare for OS/2 is not a trivial task. If you've had trouble getting a handle on the important differences, Nance's article will surely help.

That's not the only kind of networking happening, either. How about networking PCs to the telephone? That's what Microsoft has in mind with its Windows Telephony API (see "Partners Seek to Unite Phone and PC" on page 107). The idea is relatively simple: Establish the standards necessary for enabling PC-driven telephone applications software and for connecting PCs to existing phone systems and PBXs.

Concurrently, IBM is doing its level best to push more than voice lines through PC networks. In fact, IBM wants to serve up video on OS/2 (see "IBM has High Hopes for Multimedia on OS/2" on page 110). To accomplish that, IBM has designed a set of multimedia tools that share the name Ultimedia that may give OS/2 an advantage over Windows in the multimedia arena.

And, if all that's not enough, there's more. From user's perspectives to symmetrical multiprocessing, you'll find it in our special report. We've also included a roundup of interesting products to help you find what you need.

Finally, to take advantage of either NT or OS/2 running on a high-performance processor, software compilers have had to advance. Check out Oliver Sharp's excellent article on compiler technology (see "Compilers: Essential Partners" on page 135). If you develop software, you cannot afford to miss Sharp's technical discussion.

What more can I say? Already I feel a little bit like a Ginzu knife salesman (but wait, there's more...). It's just hard to hide my enthusiasm for this issue. The Windows and OS/2 debate is raging, and I think the BYTE editors and writers have done the best job of anyone to bring light to the subject.

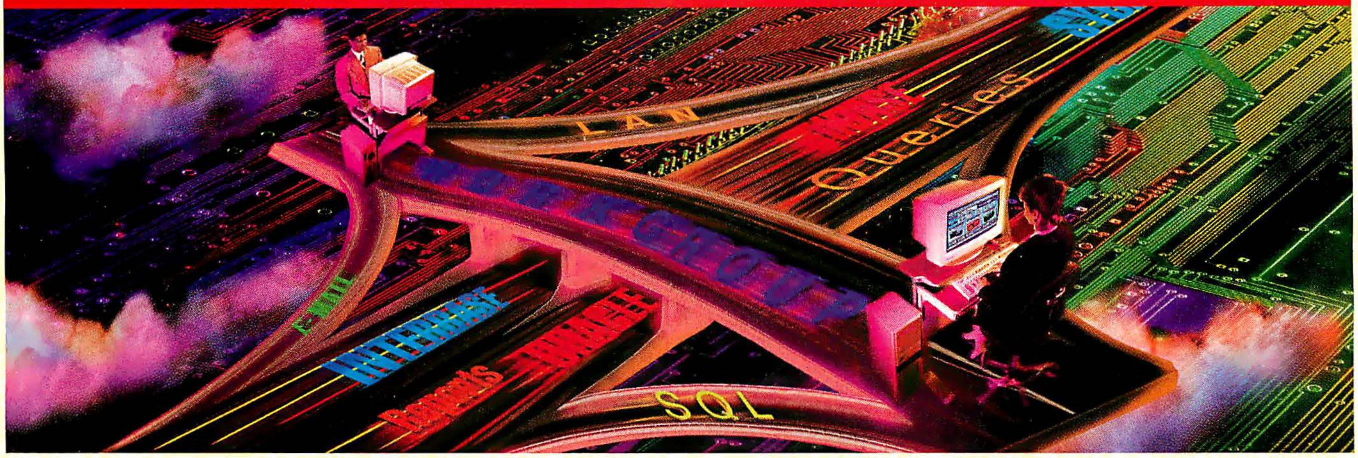
And no, we haven't forgotten Unix, PowerOpen, NetWare, the Mac, and other important operating systems. But, for this issue, we wanted to focus on the players currently hogging the spotlight—Windows and OS/2.

It doesn't end here, though. In upcoming issues, we promise to keep you posted on developments as they happen. We also promise to bring you an in-depth analysis of several key technologies and how they are implemented across all the advanced operating systems. And that's something you won't find anywhere else but in the pages of BYTE. Stay tuned—we're just getting started.



DENNIS ALLEN, EDITOR IN CHIEF

THE #1 WINDOWS DATABASE



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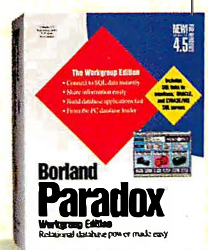


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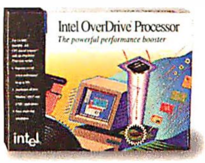
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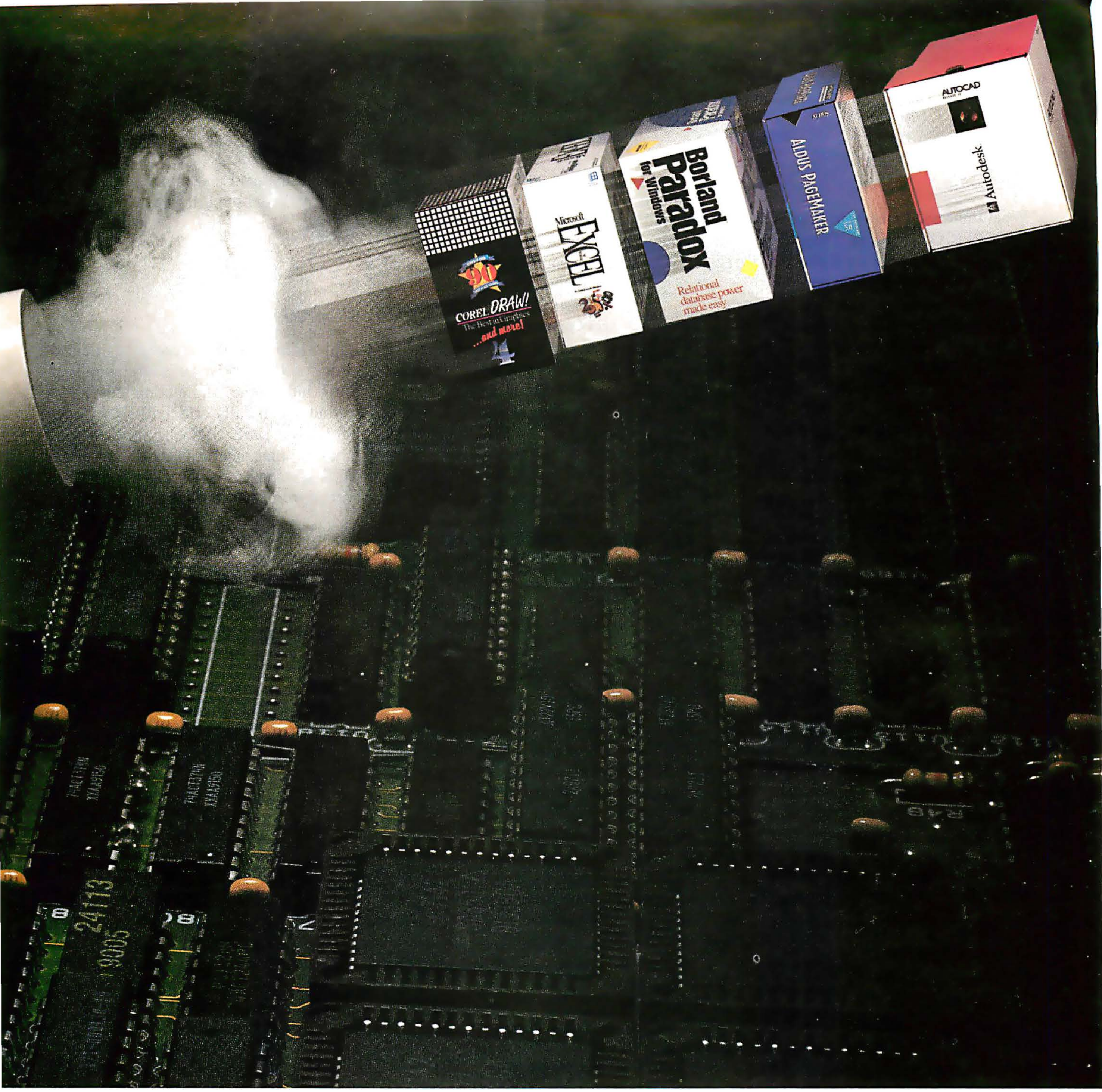


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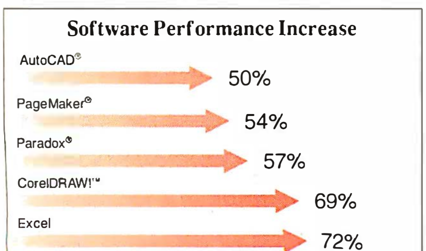
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Letters

Fax Plus OCR

What impressed me about Stan Wszola's "Fax Plus OCR: More Than Meets the Eye" (August) was its Rube Goldberg quality. One computer is to convert a word processing file into a voluminous bit map, which is then transmitted over a narrow channel. On arrival at a second computer, this bit map is laboriously converted back to text.


Fax Plus OCR: More Than Meets the Eye

OCR should be done at the originating fax machine, to achieve compression far in excess of anything obtainable by treating characters as bit maps. The time is ripe for someone to create such an extension, without waiting for the standards committee. Keep it simple.

Andrew D. Todd
Philadelphia, PA

Elegant Windows Dialog Boxes

In the August Some Assembly Required, Gen Kiyooka suggests the auto-reconfiguring dialog box in Word for Windows 2.0 is the result of the Microsoft Applications Group's "constant stream of new interface ideas." Oh, please—Mac users have been treated to this interface object in the Control Panel since System 4, back in 1987. Let's give credit where credit's due.

Fred Martin
Cambridge, MA

I think it's fair to say the Applications Group at Microsoft has contributed to, informed, and proselytized fine GUI design, both on the Mac and under Windows. The article's context was Windows development, and the Word options dialog box was an early implementation under Windows, although certainly not the first I'd seen. Originally, my article concluded with a certain wistful glance toward the exemplary toolbar design in Windows Excel, perhaps suggesting yet another idea from the stream of our UI cultural consciousness, which can be attributed, in reductionist thinking, to any of a number of sources.—Gen Kiyooka

Pournelle and Windows Word Processors

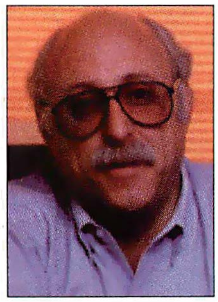
Hooray for Pournelle's gripes about Windows word processors. They clutter the screen with icons and can't handle file naming or filing. Worse, I suspect that not a single Windows word processor programmer is a touch typist.

Commands should be easy to type and remember. Give us a collaborative article between programmers and writers about the architecture of a useful word processor. Forget the tiresome comparison of features. I'm interested in fast typing, a hot-shot command structure, minimal use of the mouse, a huge file capacity with multiple files at my fingertips, sophisticated searching, indexing, and a spelling checker with just enough grammatical smarts to tell the difference between the words *to* and *too*.

Donald Kingsbury
Montreal, Quebec, Canada

They Just Don't Get It

Walter Mossberg's "They Just Don't Get It" (August) hit the nail on the head. I purchased a hand scanner six months ago, and it's still not hooked up. It requires a mouse, and there is a conflict with the ports. I had to upgrade from DOS 3.2, so I bought DOS 5.0. I could not upgrade because I needed a 5¼-inch drive, and I only had a 3½-inch drive. So I bought a 5¼-inch drive. I had a conflict that erased the CMOS. It took a week to get the original settings back.



My modem and Hercules card work on my 8088 but not on my 386. I have 64 MB installed and recognized when booting, but I can access only 32 MB. I'm sick and tired of "Well, we're still in the Model A era." Personally, I am in the boycott era. When "they" finally get it, then I'll buy it.

Lowell Allen
Adolphus, KY

I couldn't agree with Mossberg less when he states, "Personal computers are just too hard to use, and it's not the fault of the people who use them." Oh, but it is. You cannot get about in an information age if you are unwilling to learn its most basic tool. We effectively deeducate the masses while trying to make them happy. The easier we make a thing, the more people will buy it and be satisfied with it, but it remains a magical and mystical thing, not born by them but borne by them.

Fletcher Bonds
Address not provided

IBM and EMF

Paul Saffo's "A Conspiracy of Silence" (July) on EMF radiation was compelling. Saffo indicts the whole computer industry but specifically criticizes IBM. Since September 1992, IBM has introduced 11 monitors that meet ISO 9241 Part 3 and MPR-II standards, as well as three VLMF (very low magnetic frequency) monitors.

Jeffry Ullman
Advisory Systems Engineer, IBM
Coral Gables, FL

For PowerPC Information

I'd like to learn more about the MPC601 processor and the PowerPC architecture featured in your August cover story. Can you point me in the right direction?

Steven Monsees
Nashua, NH

Contact IBM's Technology Products Literature Distribution Center at (800) 426-0181 or fax (708) 635-3620; ask for the PowerPC 601 information kit. Or write to IBM, 1000 East Business Center Dr., Mount Prospect, IL 60056.

Contact Motorola's Literature Distribution Center at (800) 441-2447; fax (602) 994-6430. Motorola's PowerPC 601 RISC Processor user's manual (P/N MPC601UM/AD) is $6.50.—Eds.

Clarification

In case it wasn't clear to all readers of the August BYTE, the specific part number for IBM Technology Products' PowerPC 601 is PPC601 (TP25PPC601); Motorola, Inc.'s, specific part number is MPC601. IBM will also manufacture and distribute the PPC603, PPC604, and PPC620.

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-Greg Loveria
BYTE

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CD-ROM Today

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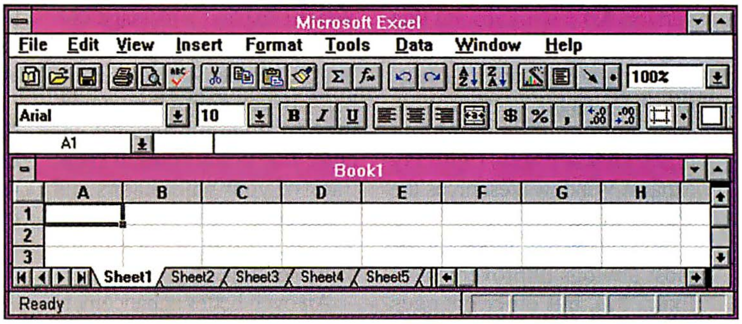


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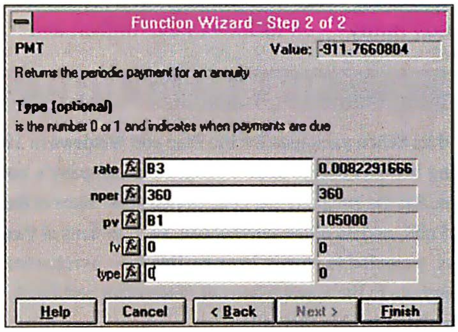
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SPREADSHEETS

Excel 5.0 Gets Smart



Microsoft improved Excel 5.0 workbooks with Quattro Pro–like page tabs.



Excel's Function Wizard dialog box elevates function help to a new high.

Packing lots of new bells and whistles, Excel 5.0 for Windows certainly looks good. But new integration capabilities with other Microsoft Windows applications may prove a stronger incentive to upgrade.

BY NICHOLAS JOHN DELONAS

Excel has long been Microsoft's flagship application. Its users have come to expect excellence, and that's generally what Microsoft has delivered. Excel 5.0 continues that noble tradition and represents an evolutionary, rather than revolutionary, step forward. That's good news, because Excel 4.0 was already a good product. However, in embracing technologies like 3-D worksheets and advanced data modeling in version 5.0, Microsoft is only now catching up to competitors like Lotus and Borland.

Excel 5.0 introduces many novel user-friendliness features, which Microsoft is touting as a new kind of spreadsheet "intelligence," called IntelliSense. IntelliSense, which Microsoft is adding to applications such as Word 6.0 for Windows and PowerPoint 4.0, senses what you want to do, to help make routine and complex tasks easier to automate and complete.

If you type a formula with an open parenthesis and don't add the closing parenthesis, Excel adds it for you. Excel's developers have obviously put a lot of work in adding intelligence to this version. These new properties should make Excel 5.0 easier to learn and use than its predecessor, and that will be an important consideration for any organization looking to standardize on a spreadsheet program.

But in today's graphical-interface world, users want more than just new features: They also want consistency and integration among their various applications. More than half of all sales of Excel for Windows are now achieved through sales of Microsoft Office, so it's no wonder that the company beefed up Excel 5.0's ability to share data with other Windows applications, especially other Microsoft applications.

Excel 5.0 has itself become much more standardized. Microsoft changed the menus and dialog boxes to closely match those in Word 6.0, as well as a future version of PowerPoint that should ship in January. People using these products will see a consistent interface, and the standardization of features doesn't stop there. A standard macro language (see below), OLE 2.0, and other features are starting to blur the boundaries between Microsoft products.

NEW EXCEL FEATURES

- **True 3-D worksheets.**
- **In-cell editing.**
- **Rich text in cells: lets you use more than one type of format on text in a single cell.**
- **Tool tips: tiny explanatory boxes that appear below each toolbar button when you pause the mouse pointer over that button.**
- **Full support for *OLE 2.0*.**
- **Tighter integration with other Microsoft Office applications.**
- **Custom AutoFill: lets you create your own series, such as business divisions, for AutoFill operations.**
- **Accounting-underline text styles: conform to accounting standards.**
- **Trend charts: automatically chart various types of trends.**

New Ease-of-Use Features

Users will see a more intuitive multisheet interface in Excel 5.0. Following the lead of Quattro Pro for Windows, Excel displays a tabbed index to its workbook, which happens to be the new default-document type. Not only can you name these page tabs, but you also can move them by dragging and dropping. That's an advantage over Lotus 1-2-3 for Windows' fixed-page structure.

continued

The new workbooks don't just look good. Excel 5.0 represents the first time the product fully embraces the 3-D spreadsheet concept. Microsoft has improved the functionality of the 3-D workbook over version 4.0's workaround that used cross-tabulations. The 3-D syntax is now simpler, selecting 3-D ranges is improved, and, most important, adding many sheets doesn't quickly exhaust Windows resources the way it did in version 4.0.

Worksheet tabs represent the most obvious improvement in Excel 5.0, but other changes aren't merely cosmetic. For example, Excel 5.0 adds many more wizards for task automation. Another improvement is Tip Wizards, which offer advice on how to better accomplish spreadsheet chores. For example, if you choose Edit-Copy from the menu, a Tip Wizard displays a message saying, "You can use the 'Copy' button on the Standard Toolbar." If you Edit-Copy again, the Tip Wizard offers yet another way to copy data. It keeps track of your work habits and won't bother you with the same advice more than once in the same session.

An even better enhancement is the Function Wizard. Click on its icon in the toolbar, and it gives the ultimate in function-building help. Excel breaks out the function's arguments into text boxes, and the dialog box shows you the value of the function given the arguments before you commit the function to the worksheet. This is definitely neat stuff for novices and gurus alike.

Data Access and Analysis

External data access is one area where Excel has lagged behind the competition. This new version improves matters somewhat by replacing Q+E with the Microsoft Query technology borrowed from Microsoft Access. While this gives you query-by-example friendliness and more data-access options, I still prefer the better-integrated Datalens technology that you get with Lotus 1-2-3.

Excel 5.0 does include a powerful new data-analysis tool, though, called the PivotTable. This is a multidimensional table that lets you manipulate and rearrange views of summary data in a manner that is similar to Lotus's Improv for Windows. While PivotTables are quite potent, they are probably likely to appeal only to power users, because I did not find them particularly intuitive.

Programmability

Of course, there's nothing wrong with appealing to power users, and Microsoft certainly hasn't forgotten them in its drive toward more user-friendliness. The new Excel has some dramatic changes on the high end. The most stunning is the introduction of Visual Basic for Applications as the new macro language. While Excel 5.0 will fully support the old macro language (which many users found arcane), it is, for all practical purposes, now obsolete.

While some macro mavens may lament this fundamental change, most should welcome it. The move to a standard macro language is a great one. Soon, all members of Microsoft Office will share Visual Basic as a common language. Throw in OLE 2.0 automation, and complex cross-application development is suddenly much less troublesome.

Excel 5.0 is an exciting product full of improvements, some of which are immediately apparent, and others that are more subtle. Managers who are making buying decisions for whole departments would do well to give Excel 5.0 a good look.

IT'S A FAMILY AFFAIR

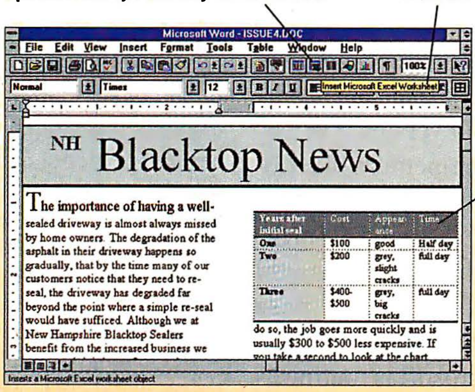
When Microsoft introduced its Office packages for the Mac and Windows in 1989 and 1990, respectively, the packages were mainly marketing bundles designed to highlight the company's word processing, spreadsheet, and presentation graphics programs. But the company has been working ever since at improving the integration and consistency among Word, Excel, PowerPoint, and its other applications. New versions of these three applications will be integrated with Office 4.2 for Windows, expected to ship in January. However, purchasers of Office 4.0, which will have the new Word 6.0, will be able to upgrade to the new versions of PowerPoint and Excel, when they become available later this year, for free. Office 4.0 is slated to ship this fall.

To bolster the consistency of its applications from one package to the next, Microsoft designed the menu bars of Excel, Word, and PowerPoint so that they will now provide the same choices (e.g., File, Edit, and View), except for the third option from the right. Microsoft has coined a new term, OfficeLinks, to describe the integrating features that mesh these applications. The new Word for Windows supports OLE 2.0. But in one example of a feature Microsoft added that goes beyond the standard object embedding of OLE 2.0, Word 6.0 for Windows now has an Excel toolbar icon that you can use to insert and graphically size an in-place Excel 5.0 spreadsheet object (provided Excel is present on your system).

Other integrating features are simply hard-coded into the applications and don't ride on top of OLE 2.0 at all. PowerPoint 4.0 for Windows, expected to ship this winter, will have a Report It feature that takes a PowerPoint presentation and converts it into a Word for Windows outline.

The Excel toolbar icon in Word 6.0 for Windows lets you place an Excel 5.0 spreadsheet object directly in a document.

The new ToolTips feature lets you quickly learn what a toolbar button does.

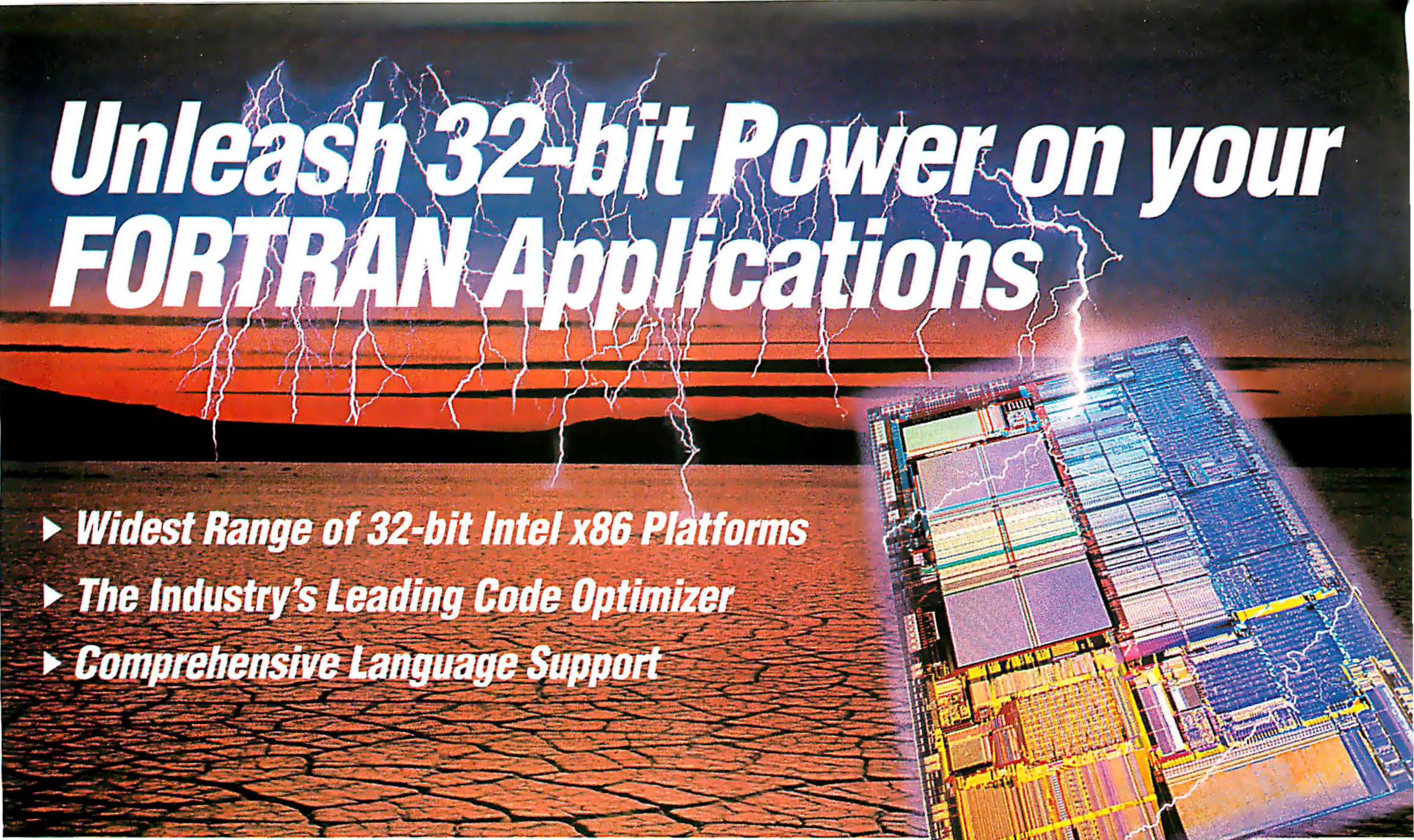


Word 6.0 now automatically formats and sizes tables just like Excel. You can pick from preset formats and then apply special formats to certain rows and columns.

Although the integration in Office has come a long way in the past three years, it still has a ways to go. Currently, only Excel 5.0 can both control and be controlled by other applications through Visual Basic Applications edition (VBA). Word 6.0 cannot control another application through VBA—it can only expose its own WordBasic objects so that Excel can drive it. PowerPoint 4.0 will not be able to control or be controlled by other applications through VBA. However, Microsoft is committed to continually improving the situation in both the Windows and Mac versions of Office. The company has established an Interoperability Design Group that will help ensure this happens.

—Dave Andrews

Office 4.0 for Windows (standard version): Excel, PowerPoint, Word, and Access, $750. Professional version: (substitute FoxPro for Access), $949.



Power. Unleash the 32-bit power of Intel's 386, 486 and Pentium processors on your most demanding FORTRAN applications with WATCOM's 32-bit FORTRAN. F77[32] delivers 32-bit performance. The 32-bit flat memory model simplifies memory management and lets applications efficiently address large amounts of memory. Powerful 32-bit instruction processing delivers a significant speed advantage; typically a minimum 2x processing speedup. Together, the power of F77[32] and these 32-bit processors provide a desktop platform that is capable of handling mainframe FORTRAN applications.

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- **32-bit DOS** host and target support; includes the DOS/4GW 32-bit DOS extender by Rational Systems with royalty-free run-time and virtual memory support up to 32Mb.
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- **32-bit Windows 3.x** target support; includes WATCOM's 32-bit Windows Supervisor, and enables development and debugging of true 32-bit Windows 3.x applications and DLL's.

Porting. To ease porting of existing code from other platforms, F77[32] has been enhanced with VAX, FORTRAN 90, Microsoft and IBM VS language extensions. F77[32] supports the full FORTRAN 77 ANSI standard and is compatible with IBM's SAA FORTRAN language definition.

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Price. WATCOM FORTRAN 77[32] v9.5 has a suggested retail price of $599*. Dealers may sell for less. For additional information or to order direct call **1-800-265-4555**. You can also call our FAX Back system 519-747-2693 from your fax machine for immediate product information.

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Circle 146 on Inquiry Card.



Even a *free* memory manager may not be a bargain—especially if it can't give you all the memory you need.

Introducing QEMM 7
The Memory Manager Worth Paying For

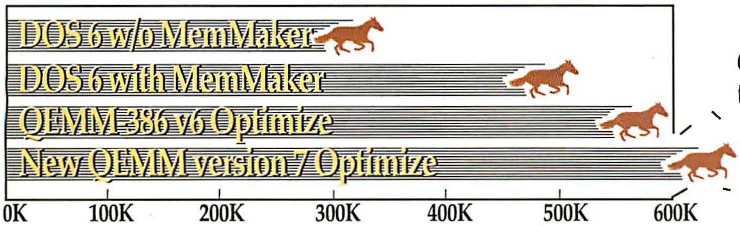
The newest version of the Quarterdeck Expanded Memory Manager (QEMM), version 7, once again is extremely innovative in using the critical area between 640K and 1024K. It finds space for more TSRs and drivers in this area than anyone thought possible. It optimizes this area, taking into account the many drivers that need more memory at start-up than when running; instantly calculating millions of possible memory configurations to find still more memory for your programs to use. And it treats the rest of memory as a giant pool to instantly fulfill the needs of all of your programs—whether they use extended or expanded memory. Whether your PC has 1 megabyte or 16, you can benefit from new QEMM 7.

Instant Riches

What does more memory mean in a practical sense? It means that your DOS and MS Windows programs run faster, smoother and more reliably. It means you can continue to add valuable utilities, drivers, TSRs and new capabilities to your PC. Whether it's workhorse drivers like LAN utilities and fax drivers; productivity-enhancers like disk caches and disk compressors; or fun and exciting capabilities like sound boards, CD ROM drivers, graphics tablets, etc. The better your memory is managed, the more versatility and flexibility your PC has. QEMM 7 lets you have it all without fear of 'out of memory' messages or crashes.



How to Look a Gift Horse in the Mouth



We tested DOS 6 with and without MemMaker and with QEMM 6 and our new QEMM 7 runs away from all of them. See details of test conditions listed below.

DOS 6 Giveth; DOS 6 Taketh Away

The best feature of new DOS 6 is the stable of utilities it includes. Trouble is, they all eat up memory. DoubleSpace file compression needs 43K, Vsafe anti-virus needs 7-45K, Smartdrv disk cache needs 28K and even Undelete takes 10-14K as a resident program. Using Microsoft's free memory utility, MemMaker, you could easily end up with a net loss of available 'conventional' memory in DOS 6.

New QEMM 7 takes the best of the new DOS 6 features into account, finding ways to give you more free memory for your program while taking full advantage of DOS 6. One new QEMM 7 feature, DOS-Up, moves the DOS 6 kernel, its data and resources to memory above 640K (this feature also works with DOS 3-5), freeing 7-70K. Another new QEMM 7 feature, Stealth DoubleSpace, frees 40K of the memory addresses used by DoubleSpace and makes them available for other drivers and TSRs. Both features ensure that the all-important memory below 640K is free for your programs. And QEMM 7's seemingly small feature of supporting multiple configurations gives you the flexibility and ease of setup that you expect. (MemMaker doesn't work well with this important DOS 6 feature.) That's why it makes more sense than ever to put your money on the best memory manager.

Page Frame: the Key to Your Future

There's been a lot of talk about our patent-pending Stealth technology. Jealous talk, mostly. Because nobody else can touch its performance. Our Stealth ROM feature, pioneered in QEMM 6, frees 48-115K of ROM addresses for use by TSRs and drivers. Our Stealth DoubleSpace feature, described above, frees another 40K. And as you might imagine, there's more to come.

The key to Stealth is its use of a 64K reserved area above 640K called the page frame. Besides being used by Stealth, the page frame is used by Lotus 1-2-3 r2.x for larger spreadsheets and WordPerfect 5.x for larger documents, DESQview for multitasking, Novell Netware, IBM LAN Server and DECnet for reducing the network driver memory footprint, plus games like Wing Commander, Car and Driver, Ultima Underworld II, Wolfenstein and others for fast action. You sacrifice all this when you turn off the page frame (which other memory managers do to maximize available memory above 640K). It's this use of the page frame by Stealth that lets you set up your PC with a mouse, CD ROM, sound board, a network such as Novell NetWare, reserve 8-24K of extra memory for optimal MS Windows performance, use all of DOS 6's memory-hungry utilities and still have more than 630K available for your programs. (Compared to DOS 6's 527K available in the same configuration, after using MemMaker).



Prior versions of QEMM won just about every competition in sight, as well as remaining the #1 best-selling memory manager 5 years straight.

There's lots more to QEMM 7:

- Tuned for MS Windows
- New ability to use Vidram inside MS Windows
- DPMI Host
- Pentium Support
- Laptop suspend/resume support
- PS/2 micro channel adapters
- Compaq support
- Fine tuning tools for power users
- 32-bit architecture for speed
- Enhanced compatibility in response to hardware needs of our millions of users:
  - Detects adapter RAM and ROM and bus-mastering hard drive controllers
  - Monitors DMA access into memory
  - Supports Shadow RAM

Easier to use for Novices, More Power for Experts; More Memory for All

Our seventh-generation thoroughbred QEMM has improved ease-of-use, with Express Install and Help features. And for power users, Advanced Install and editable parameters and troubleshooting hints.

And QEMM 7 comes with Manifest, the award-winning memory analyzer—enhanced for more flexibility with Pentium testing, laptop battery reporting, network analysis and editable configuration files.

The new and ever more exciting capabilities coming to your PC will all compete for memory with your favorite applications, TSRs and drivers. And that makes QEMM 7 the front runner in your efforts to get get the best performance out of your PC today—and tomorrow.

Quarterdeck

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QEMM Users: upgrades are available from dealers.

You can also buy direct from Quarterdeck. Call (800) 354-3222 ext. 1D7 and ask about our special Game Pack offer with your upgrade!

How we got the chart numbers: CPU—486/33 ALR Power/business VEISA machine equipped with 16 megs of RAM and running MS-DOS 6. Comparisons were done using the following memory managers: QEMM 7, QEMM 6.02, MS-DOS 6 MemMaker. In addition to the driver (or drivers) required by each memory manager, the following drivers, DOS resources and programs were loaded for all comparisons: in the CONFIG.SYS file: SETVER.EXE, DOS=HIGH, FILES=20, BUFFERS=10, STACKS=0,0, MVSOUND.SYS, SNDBK12.SYS, SLCD.SYS, DOS SHELL=statement, in the AUTOEXEC.BAT file: VSAFE, MSCDEX, UNDELETE, LSL.COM, NE2000.COM, IPXODI.COM, NETX OR EMSNETX, MOUSE.COM, SMARTDRV.COM, PRTSCCAP.COM.

Circle 125 on Inquiry Card.

COMMUNICATIONS

E-Mail Unplugged by Wireless WANs

Wireless WANs (wide-area networks) have been slowly chugging toward mainstream business use. But the wireless-data movement is picking up steam, and the engine that's driving the demand for wireless WANs is convenient access to the E-mail systems that people depend on through the wired-phone network.

"E-mail is the logical first application for wide-area wireless networks," notes Eric Arnum, editor of *Electronic Mail and Micro Systems*, a newsletter published by BRP Publications (Washington, DC). "E-mail works, it's easy, and it's become an all-purpose data transfer system."

People wanting wireless E-mail have a few choices and will soon have more. Intel recently introduced three packages that put all the pieces—hardware, software, and network—into a reasonably priced bundle. The products are designed to work with RAM Mobile Data's radio-packet network, which charges $75 a month. The Intel packages cost $795 apiece.

"We think E-mail is the most-wanted application in the wireless field, and that people would prefer to use what they already know to get it," says Tom Jackson, wireless marketing manager at Intel.

Intel is not the first company to offer a coordinated solution for wireless E-mail. Ericsson GE is selling a $995 bundle called Mobidem Kit, which works with RadioMail's wireless service. Motorola, which currently operates a one-way, pager-based E-mail service called Embarc, says it plans to introduce two-way E-mail products in 1994, perhaps using the Ardis wireless network it runs with IBM. Many other companies are working on wireless products for delivery late this year and in 1994.

The next step in the evolution of wireless E-mail will be reducing the size of the hardware from a bulky external modem to a thin card that slides into the PCMCIA slot now found in many notebooks and hand-held PCs, including Apple's MessagePad. Motorola and Megahertz have announced their intentions to produce wireless modems on PCMCIA cards in 1994. "Until the PCMCIA two-way transceivers for RAM and Ardis come out, there will be limited acceptance," says Mark Eppley, chairman and CEO of Traveling Software (Bothell, WA), which is working on wireless products.

There are other obstacles, including the fairly short battery life of most portable modems and computers. But many believe it's only a matter of time before people begin embracing wireless E-mail as eagerly as they have cellular phones.

—**Christopher O'Malley**

PACKAGES FOR WIRELESS E-MAIL

INTEL'S WIRELESS MODEM:

- **wireless modem—a Hayes-compatible radio modem (also sold by Ericsson GE as the Mobidem)**
- **wireless version of Lotus's cc:Mail or Microsoft's Mail**

Both packages require a $795 server version.

WIRELESS MODEM (EASYLINK):

- **wireless modem**
- **AT&T's Access Plus software (for use with its public EasyLink network)**

ERICSSON GE'S MOBIDEM KIT:

- **Mobidem wireless modem**
- **Hewlett-Packard's HP 95LX palmtop**
- **wireless E-mail software and gateway service from RadioMail**

RadioMail is also available for other DOS systems and was recently introduced for Apple's PowerBook portables.

CDPD NETWORK EMULATOR FOR DEVELOPERS

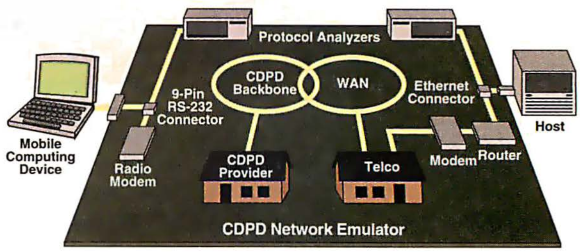
Wireless communications may get a boost from a new Windows-based development tool that emulates a complete CDPD (cellular digital packet data) network. The software emulator, called CDPD Workbench, lets developers test their applications while simulating various levels of network traffic, radio interference, vehicle speeds, and other variables that are difficult to create under actual conditions.

Workbench was introduced in September by Cellular Data (Palo Alto, CA, (415) 856-9800). Workbench emulates the entire CDPD network between the mobile-computing device (known as the MAS, or Mobile Application Subsystem) and the host device (the F-ES, or Fixed-End System).

"Given the alternative, which is to put an engineer in a car and drive around a lot, the price [$3995] is exceptionally attractive," says Jacques A. Robinson, president and CEO of Cellular Data. Without rigorous testing, says Robinson, developers can't be sure how their wireless applications will fare in the hostile environment of mobile communications.

Just before the official launch of CDPD Workbench, as this article was going to press, Cellular Data was informed that its key source of funding would no longer be available. A spokesperson said the company is seeking alternative sources. —**Tom R. Halfhill**

The Network Emulator Replaces...



CELLULAR DIGITAL

Cirrus Subsidiary Leads CDPD Push

Pacific Communications Sciences, Inc., a subsidiary of Cirrus Logic located in San Diego, is playing a central role in the development of CDPD (cellular digital packet data), the technology that wedges bursts of bits into minuscule pauses in the analog cellular-phone system.

PCSI was a key developer of CDPD technology and specifications, supplying prototype equipment to the nine-member CDPD consortium and helping conduct field tests in 1992. This past August, only days after AT&T revealed its plans to acquire McCaw Cellular, PCSI announced that it had been selected by AT&T to supply equipment for adding CDPD capability to cell sites. PCSI's electronics will be bundled with other AT&T products and services and sold to cellular carriers upgrading to CDPD.

continued

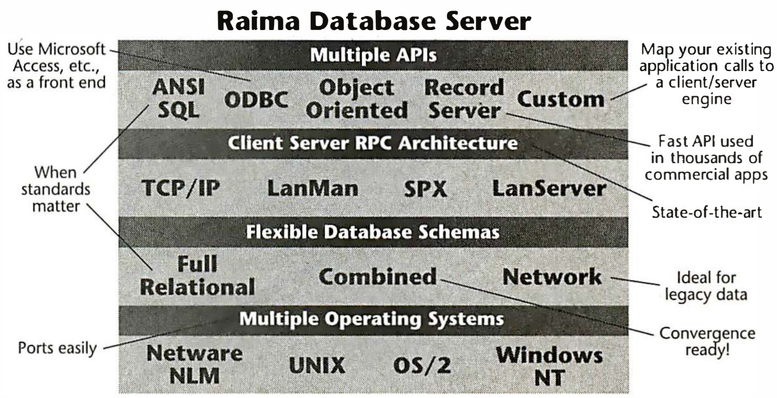
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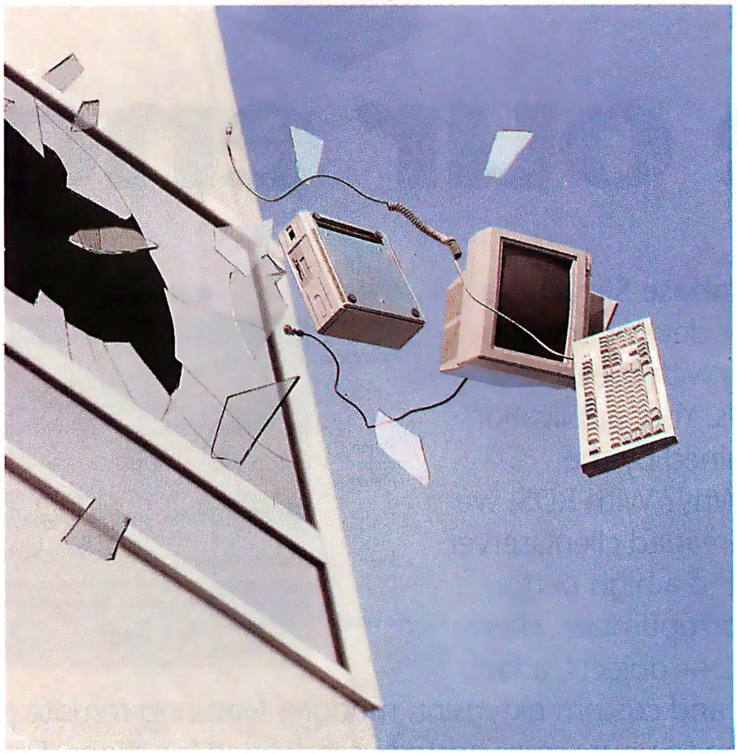
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Two w make a



If patience is a virtue, it would be tough to find anyone more virtuous than a 386 user.

Of course, you're not waiting to be canonized. You just want to get your spreadsheet crunched, printed and e-mailed before your boss's boss calls you looking for it.

Performance Benchmarks		
(figures indicate relative performance)	**Intel i386**	**Cyrix 486 Upgrade**
MS Excel 3.0	1.0x	2.1x
MS Word 2.0	1.0x	2.8x
Micrografx Designer 3.1	1.0x	2.6x
Benchmark tests run on IBM PS/2 Model 70/20MHz.		

The new Cyrix 386-to-486 Upgrade Microprocessor delivers application performance that's twice as fast. And that's twice as smart.

Now if you had a 486, you wouldn't have this problem. But all that wishful thinking goes out the window when you consider the double-knots on your company's purse strings.

Fortunately, there's a smarter alternative to the downward migration path pictured above. It's called the 386-to-486 Upgrade Microprocessor.™ And it's only available from Cyrix,® the smarter microprocessor company.

It's smarter because it's the only single-chip upgrade solution of its kind. And as such, the most cost-conscious way to replace the pedestrian 386 computer you have, with the searing 486 power you want.

Our upgrade chip acts just like a 486, and with good reason. It has Clock Doubling, a 1K on-chip cache

ays to 386 fly.



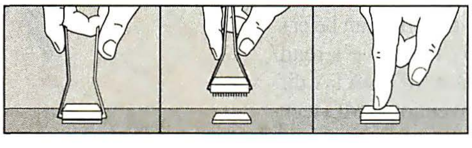
and enhanced Cx486 technology. Which means it delivers *twice* the application performance, and 100 percent compatibility with all your software.

MICROSOFT. WINDOWS COMPATIBLE

yes It runs with NetWare

Like DOS, Windows and OS/2. Even Windows NT. It's also certified software compatible in Novell, Banyan and Lan Manager nodes.

What's more, it's easy to install (it takes all of 15 minutes), and costs under $400. So it's also easy to justify to



Talk about immediate gratification. Just use the chip removal tool provided to pull out your 386DX chip (16, 20, and 25 MHz versions only at the moment), and plug our Cyrix Upgrade Microprocessor into the empty socket. Then get ready for screaming 486 power.

even the stingiest bean counters.

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Cirrus Subsidiary Leads CDPD Push

In addition to its work on the infrastructure side of CDPD, PCSI is providing products for the subscriber side. The company was awarded a contract in November 1992 to supply IBM with CDPD modules for mobile computers; IBM was expected to announce this fall a model of the ThinkPad with PCSI's CDPD modem built in. The company is also working closely with Apple to develop wireless-communications features for next-generation MessagePad systems.

Brandon Nixon, product line manager for wireless communications at PCSI, says that trials of real CDPD systems will begin this month, with many areas rolling out in the first half of 1994. National coverage and roaming agreements between carriers likely won't be in place until 1995. Nixon believes that there will be a strong link between CDPD and the use of hand-held computers like the MessagePad. "CDPD will really come on strong with PDAs [personal digital assistants]," he says.

On the other hand, he notes, the technical problems of implementing a cellular radio, especially in a PCMCIA form factor, are quite challenging, because electromagnetism from the screen interferes with the signal. PCSI's product for IBM will be embedded in the system, not on a PCMCIA card, but the company expects to deliver card-size products later, as does Motorola.

CDPD offers an attractive business opportunity for carriers, because they will be able to realize greater profits from their existing cell sites. A study by IBM and McCaw Cellular found that even at peak usage, roughly 30 percent to 40 percent of the total bandwidth at a site is idle; these holes can be filled with data packets billed at 5 to 7 cents each.

—**Andy Reinhardt**

DATA STORAGE

Sony's MiniDisc for Data: Future Floppy?

Sony's recent decision to adapt its 2.5-inch audio MiniDisc for computer data storage poses a new alternative to conventional floppy disks, which are falling far behind the curve of today's mass-storage requirements.

MD DATA, as Sony's new MO (magneto-optical) format is called, offers a promising combination of storage density, economical mass duplication, and cross-platform compatibility. MD DATA disks come in three variations: writable, read-only, and a hybrid that's partly writable, partly read-only. They all store 140 MB of data per disk, and all disks are readable on the same drive. The disks are protected against physical damage by a shuttered cartridge and are more resistant to stray magnetic fields than conventional floppy disks, according to Sony. Because MD DATA has its own file system, disks are interchangeable between PCs, Macs, and other supported platforms.

Writable MD DATA disks can be erased and rewritten any number of times. Blanks are expected to cost about $20. That's nearly as much storage as a hundred 1.44-MB floppy disks at a much lower cost per megabyte. For software publishing, read-only versions of the disks (called MD-ROMs) can be mass-produced using the same premastering process as CD-ROMs. In quantities of thousands, they could cost only $1 or $2 each.

Hybrid MD DATA disks are intended for interactive applications in which some information is read-only and the rest of the disk is writable. Like conventional MO formats, MD DATA uses a laser to heat selective locations on the disk to their Curie point—a temperature at which the magnetic material can be easily altered by the drive's read/write head. But MD DATA differs from conventional MO technology in two important ways. First, the drive can erase and rewrite data in a single pass; regular drives require two passes. Second, this direct-overwrite technology allowed Sony to greatly simplify the optical head, thus reducing cost, size, and power consumption.

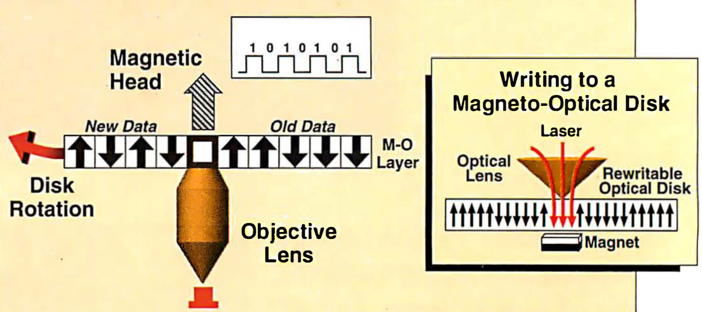
Sony hasn't announced prices for MD DATA drives, but MiniDisc audio recorders now sell for about $700. MD DATA isn't a replacement for CD-ROM because it offers only about one-fourth the storage capacity. It also won't replace hard drives because the data transfer rate is only 150 Kbps, the same as most CD-ROMs. But MD DATA could fill the need for a writable, removable storage medium that matches the growing demands of today's PCs.

The shortcomings of floppy drives are becoming more apparent as PCs accumulate megabytes of memory, hundreds of megabytes of hard disk space, and applications software that ships on a dozen or more disks. Years ago, floppy disks could store two or three times as much data as the computer's RAM, but today that ratio is reversed. Many files—such as those produced by page-layout programs—are too large to fit on a single floppy disk, even when compressed. Hence the popularity of removable hard drives for sending files to service bureaus and the widespread use of tape cartridges to back up hard drives.

MD DATA could provide a universal solution that's small enough for mobile computers. The nearest likely competitor is floptical technology, which stores 21 MB on a 3½-inch magnetic disk and offers backward compatibility with existing 3½-inch floppy disks.

—**Tom R. Halfhill**

Overwriting Technique Used for 2.5-inch MiniDisc



Sony gets single-pass writing by using three new techniques. First, the laser and the magnetic read/write head are positioned on opposite sides of the disk, and the laser remains constantly on during reading and writing. Other MO drives repeatedly turn the laser on and off while erasing and writing the magnetic signal (see the figure inset). By leaving the laser constantly on, Sony was able to simplify the design of the optical head. Normally, this would require a powerful magnetic field, but Sony also invented a new magnetic layer (i.e., terbium ferrite cobalt), whose polarity can be changed by using only one-third as much magnetic coercivity as conventional MO drives. This allows a weaker magnetic field, which in turn reduces the size, complexity, and power consumption of the head. Sony claims the new head is more efficient than regular heads and requires only about 100 nanoseconds to reverse the polarity of a spot on the disk.

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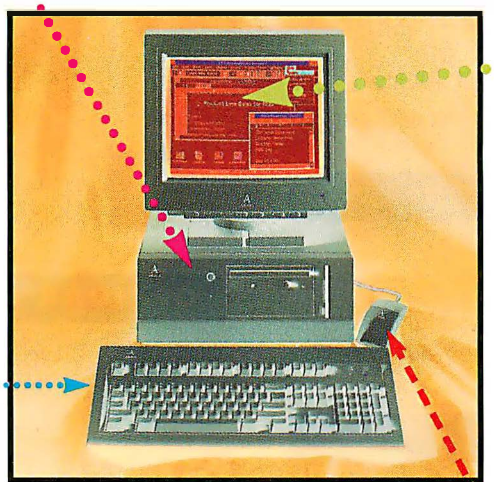
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Processor	☐486 Blue Lightning, 66 MHz ☐486DX2, 66 MHz
Memory	☐4MB ☐8MB ☐16MB ☐32MB ☐64MB
Hard disk	☐170MB ☐240MB ☐340MB ☐440MB

EISA DESKTOP (8x6)

Processor	☐486DX2, 66 MHz ☐Pentium, 60 MHz
Memory	☐8MB ☐16MB ☐32MB ☐64MB
Hard disk	☐170MB ☐240MB ☐340MB ☐440MB ☐540MB SCSI-2*

EISA TOWER (8x12)

Processor	☐486DX2, 66 MHz ☐Pentium, 60 MHz
Memory	☐8MB ☐16MB ☐32MB ☐64MB ☐Other ____MB
Hard disk	☐170MB ☐240MB ☐340MB ☐440MB ☐540MB SCSI-2

*Not available with 486DX2, 66 MHz processor.

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- 256KB processor cache
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WILL RUN ON MAC, WINDOWS, AND UNIX

First PowerPC Systems Hit the Street

It looks as though the first system to use the PowerPC 601 processor will come from—drumroll, please—IBM. The company's Advanced Workstations and Systems division plans to ship four PowerPC-based systems by the end of the year, including a server that will cost about $9000. Any future single-chip RS/6000 models that AWS will introduce will be based on the PowerPC. The company claims that the Model 250, one of the four new RS/6000s, will run two to three times faster than its older sibling, the Model 230.

The Model 250 will run the same AIX 3.2.5 applications as the current single-processor RS/6000s (Models 220 and 230), which use IBM's RISC processor. IBM says that its version of the PowerOpen environment, expected to ship this year, will also let you run Mac and Windows programs on the Model 250. Other operating systems being ported to the PowerPC platform include Apple's System 7, Microsoft's Windows NT, SunSoft's Solaris, IBM's OS/2 (perhaps in the form of Workplace OS), and Taligent's Pink.

"We've been criticized a lot for not being first to market with technology that we invented," said AWS's workstation marketing director John B. Holz, "so here's a case where we've been working real hard. We invented it, we want to be first, and, unless something strange happens, we will be first."

For people who need multiprocessor RISC systems, IBM offers POWER2, a replacement technology for the POWER chips now implemented across the SMP (symmetric multiprocessing) part of the RS/6000 line. While the PowerPC 601 is capable of multiprocessing, Holz says that the multichip POWER2 processor module is far superior to any multiprocessor array of PowerPC chips that could now be built.

At the Unix Expo show in New York, AWS also previewed the PowerPC-based notebook computer that Tadpole developed for IBM. The 5.5-pound notebook, boasting a 9.3-inch color TFT (thin-film transistor) display, is finished, said Holz, but IBM will not announce it until early next year.

The real trick for IBM will not be selling RS/6000 customers on the PowerPC. It will be persuading customers who use Intel-based systems that a PowerPC-based computer will run their DOS, Windows, and OS/2 applications. Another division of IBM's Personal Systems line of business, Power Personal Systems, came into being solely to develop PowerPC-based computers. The first of these will be client-level machines.

—Ed Perratore

Sharing the PowerPC

Three separate arms of IBM are currently developing PowerPC-related products. An additional suspect—IBM PC Co.—is sticking instead with the Intel 80x86 platform, which includes IBM variations on Intel processors, like the 486-based Blue Lightning from IBM Microelectronics. Following is a rundown of the players.

IBM PC Co.

Somers, New York
Robert Corrigan, president and CEO

At least for now, this division will develop systems based solely on the Intel 80x86 platform, despite earlier public statements to the contrary.

IBM Advanced Workstations and Systems

Austin, Texas
Bill Filip, president

This division will have introduced the first PowerPC-based RS/6000 system, the Model 250, by the time you read this. Early next year, it will bring out a 5.5-pound Tadpole-developed notebook based on the PowerPC. It will eventually replace the entire single-chip RS/6000 product line with PowerPC-based systems running AIX and PowerOpen. Multiprocessor systems will be based on POWER2 processor modules.

IBM Power Personal Systems

Somers, New York
Nobuo Mii, president

Formed with the mission of developing and marketing PC-like systems based exclusively on the PowerPC, this division expects to introduce its first products by mid-1994, which will compete with Intel-based systems.

IBM Microelectronics

Fishkill, New York
Michael J. Attardo, general manager

Formerly called IBM Technology Products, this division is the sole supplier of PowerPC 601 chips. It manufactures and sells the 6XX series to system makers and next year will introduce the PowerPC Embedded Controller 4XX series. It also makes IBM processors under a technology-sharing agreement with Intel.

—E. P.

IBM'S POWER2 SYSTEMS

For many customers of IBM's Advanced Workstations and Systems (AWS) division, the PowerPC just doesn't cut it—at least not in its present incarnation. For these high-end AIX users, whose needs rise to the level of massively parallel systems, there's the new POWER2 architecture and two systems to employ it.

POWER2 uses an eight-chip processor module that includes several processors and support circuitry (e.g., I/O and cache controllers). Because of the integration of these chips, IBM claims, a module will execute six instructions in one machine cycle. It looks like a uniprocessor to the operating system and any applications.

By contrast, an operating system dispatching instructions to an eight-processor PowerPC configuration would do so knowing there are eight processors. POWER2 modules can be implemented in the hundreds, while the PowerPC's efficiency quickly falls short beyond eight to 12 chips. Hence AWS's plans, at least for now, to limit PowerPC to single-chip implementations.

Along with the debut of POWER2, IBM has announced two system families that will use this architecture. The 990 replaces the RS/6000 970B and 980B. It may be rated the fastest RISC system in the industry, until new high-end systems appear. The new 58H and 590, running at 55 and 66 MHz, respectively, are replacements for the RS/6000 580. Existing systems are field-expandable to POWER2; no prices were yet available.

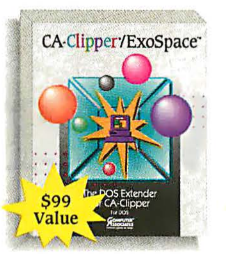
IBM is expected to announce massively parallel systems using POWER2 by the end of the year.

—E. P.

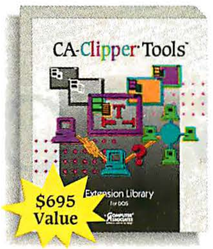
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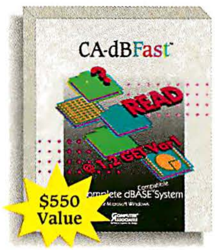
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Code Blocks	YES	NO	NO
Nested Multidimensional Arrays	YES	NO	NO
Predefined Object Classes	YES	NO	NO
Variables Modifiable in Debugger	YES	NO	NO
Customizable Reactive Error Handling	YES	NO	NO
Reads and Writes FoxPro (.CDX) Files	YES	YES	NO
Reads and Writes dBASE IV (.MDX) Files	YES	NO	YES
Reads and Writes Paradox (.DB/.PX) Files	YES	NO	NO

Comparison based on FoxPro Version 2.5 for DOS and dBASE IV Version 1.5.

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And you were told Pentium was powerful.

If you've heard the Pentium™ microprocessor was powerful, it's time you see the PowerPC™ Microprocessors from Motorola. To be perfectly candid, Pentium is fairly powerful, but it's not nearly as powerful as the PowerPC family of microprocessors.

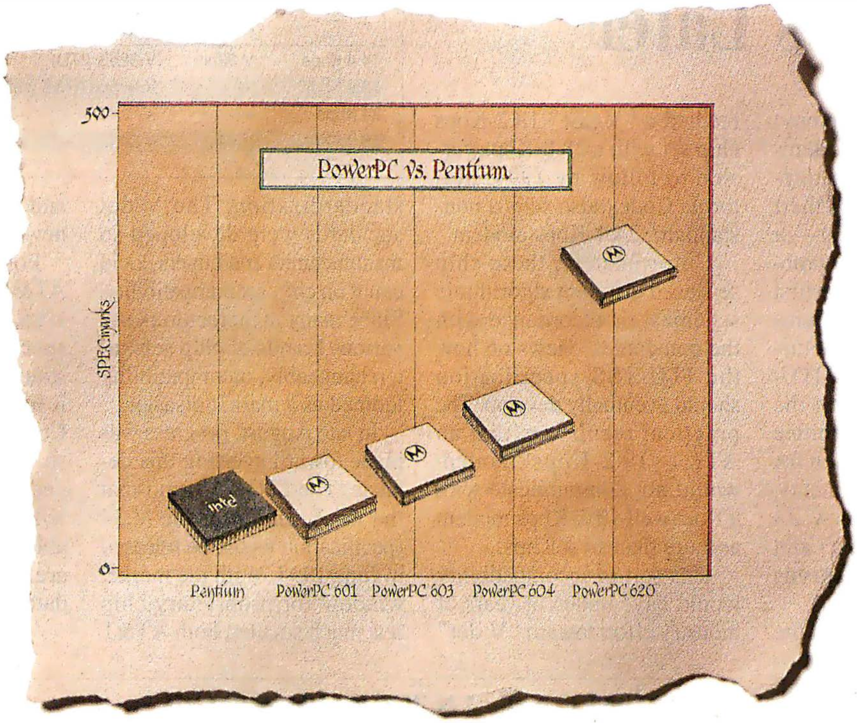
The first of Motorola's PowerPC Microprocessors, the PowerPC 601™ Microprocessor will bring workstation-like performance to low-cost PCs. Its integer performance (how fast it handles basic computer functions) is equal to Pentium's. In floating point performance (the speed you need to crunch numbers, run graphics, video, voice and the like), the 601 is a full 40 percent faster than Pentium, with no loss in integer performance.

While the 601 outruns Pentium, it actually runs cooler. The 601 draws only 8.5 watts of power to 16 watts for Pentium which, incidentally, leads to lower overall system costs.

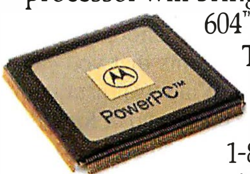
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HIGH-SPEED MODEMS

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SPEEDS:
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Just as modem vendors have supported the ITU's specifications for modem speed through the V.32bis specification, both AT&T and Rockwell have committed to supporting the V.34 specification when it is released. But until then, both companies are introducing nonstandard specifications.

	ITU-TSS	AT&T	ROCKWELL
14.4 Kbps	V.32bis	V.32bis (ITU)	V.32bis (ITU)
19.2 Kbps	—	V.terbo (AT&T, shipping)	V.fast (R, late this year)
24 Kbps	—	—	TBA (R, early 1994)
28.8 Kbps	V.34	V.34 (ITU, after 6/94)	V.34 (ITU, after 6/94)

Users accustomed to buying new high-speed modems within a year of their last upgrade will have to cool their jets for nearly another year—or risk gross incompatibility problems. Two years after the first V.32bis (14.4-Kbps) modems came to market, manufacturers are still waiting for the ITU-TSS (formerly known as the CCITT) standards committee to release the specification for the next set of improvements, known collectively as V.34 (formerly called V.fast) and promising data-pump speeds of up to 28.8 Kbps.

But the manufacturers of the chip sets that control the modems are forging ahead with products that close the gap between 14.4 and 28.8 Kbps. The problem is, these chip sets do not conform to any universally recognized standard. Users shelling out money for more speed are likely to find that the new modems will not connect, even with other superfast modems, at speeds greater than 14.4 Kbps.

AT&T and Rockwell, two central players in both the modem market and the ITU-TSS committee, are among the renegade chip-set vendors. As of this summer, the ITU-TSS, at a major impasse, had not expected to release the V.34 specification until 1995. Chip-set vendors jockeying for both market share and political power on the committee announced their plans to release superfast modems over the next year: AT&T developed a V.terbo modem with 19.2-Kbps speed, while market leader Rockwell readied a "V.fast" 19.2-Kbps chip set with a 28.8-Kbps version to follow by 1994. Motorola Codex also sells a nonstandard, 24.4-Kbps modem.

Unfortunately, these chip sets used different algorithmic schemes, in accordance with the companies' views on how the ITU-TSS specification should eventually develop. The practical result was that an AT&T 19.2-Kbps modem would not communicate with a Rockwell 19.2-Kbps modem at more than 14.4 Kbps.

This sort of incompatibility would have undercut years of industry effort toward "V-dot" standardization. The V-dot standards were developed so manufacturers and buyers could count on chip-set compatibility. Since many manufacturers use various brands of chip sets interchangeably, incompatibility loomed as a market disaster.

In late August, progress was made toward averting this debacle. The ITU-TSS said that the final version of the V.34 specification would be released in June 1994. With the market window for proprietary chip sets much smaller, both AT&T and Rockwell will support the new specification.

For the moment, however, AT&T is still releasing V.terbo. USRobotics is burning the specification onto Texas Instruments chip sets and offering it in the latest additions to its Courier line. And Rockwell is still developing V.fast. It's expected that both alternatives will appeal mainly to buyers able to control which modems are used on both ends of the data connection.

—Noa Schoenfeld

DOCUMENT INTERCHANGE

Send Your Font Worries ElseWare ...

When sending an electronic document from your machine to another, it used to be sufficient to send it as plain ASCII text, or to make sure the recipient had the same word processor you did. Now you also have to pay attention to the fonts you use in your document.

ElseWare's Font Works software, expected to ship in December, promises to make the transition from ASCII less painful. Font Works ($129) installs into your Windows environment and uses ElseWare's Infinifont technology to synthesize hundreds of fonts on-the-fly. When you open a document that uses a TrueType, Adobe Type 1, or Agfa Intellifont font, Font Works will step in and generate the font for you from a description in its extensive database. According to ElseWare, the database and Font Works software take only 2 MB of hard disk space for the 220 fonts included in the package.

Font Works uses ElseWare's PANOSE typeface-matching system to find the best match for any font you don't have installed. PANOSE categorizes fonts by style and shape. Given the PANOSE description of a font, the Infinifont generator can create any of the fonts included in the Font Works package. PANOSE is currently supported in packages from Lotus, Aldus, Adobe, Bitstream, Microsoft, and others.

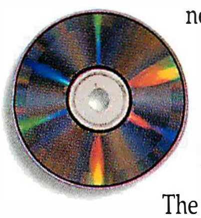
Font Works incorporates an extensive help system that assists you in picking the right typeface for a job. Font Chooser lets you build groups of related fonts that you can switch in and out of your Windows installation at will. You might have one group of fonts that you like for Ami Pro, while you want a second set for PageMaker work. Font Chooser lets you manage these font groups without hand-editing files or restarting Windows. Type Tutor lets you select a document style and then gives you suggestions for appropriate, complementary typefaces.

—Howard Eglowstein

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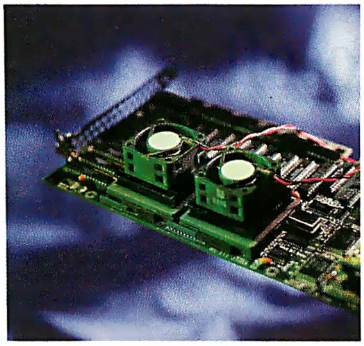
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News & Views

MULTIMEDIA

Intel's VDI Speeds Up Video, Miffs Microsoft

Intel and Microsoft are at odds over a new way to dramatically accelerate Video for Windows. Although it's likely the two giants will resolve their differences before they cause problems for users, some of the smaller companies are scrambling to avoid getting trampled in the fray.

At issue is Intel's new Video Device Interface, a software extension to video drivers that roughly doubles the speed of software-only playback in VfW. A PC that plays VfW movies at a jerky 15 frames per second could attain true full-motion video at 30 fps at the same resolution without any additional hardware. Intel says VDI also improves overall picture quality and, once installed, is completely transparent to applications and users.

What's wrong with that? Plenty, says Microsoft. To achieve its magic, VDI bypasses the Windows GDI (Graphical Device Interface) and writes directly to the video controller's frame buffer. Although Microsoft acknowledges that direct access to the frame buffer is a legitimate way to accelerate software-only video playback, it argues that Intel's implementation is premature and overcomplicated. Microsoft says VDI conflicts with a similar mechanism it plans to introduce this year.

"The technique is not rocket science," says Carl Stork, Microsoft's director of Windows platform definition. "We could demonstrate our technology now, but we're not ready. We don't understand why Intel decided to announce the VDI specification [in late August]. They should have waited until we had the spec finalized and then made an announcement together."

According to Stork, codecs can't use VDI without understanding the frame buffer's internal structure, such as whether the buffer is arranged in banks and how large those banks are. Too complicated, he says: Codecs shouldn't have to know anything about the frame buffer but its starting address.

Likewise, the new VDI driver (which can be integrated with the video driver or installed as a separate DLL) can perform such functions as clipping and scaling. Redundant, says Stork: Those tasks are already handled by the GDI.

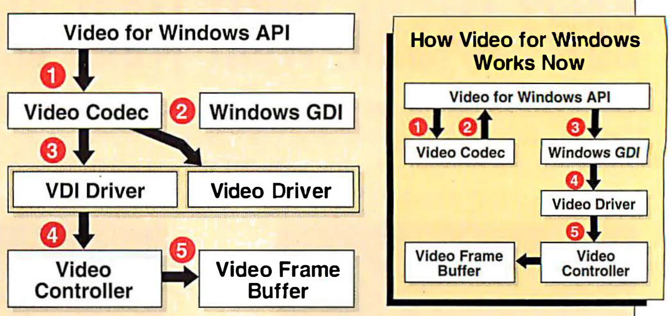
Intel contends that VDI is intended to complement the GDI, not replace it. The GDI is fine for regular graphics, says Intel, but it adds too much overhead to video playback and doesn't let codecs directly access the frame buffer in video's native format, YUV (luminance-chrominance).

Although Intel's announcement was joined by ATI Technologies, Brooktree, Matrox, Tseng Labs, Western Digital, and S3, a few vendors quietly avoided the press conference.

A spokesman for one company that declined to participate told BYTE: "We don't want to be forced to choose sides between Intel and Microsoft. We're just a small company, and we can't afford to get stepped on by a pair of 800-pound gorillas."

—Tom R. Halfhill

How Intel's Video Device Interface Works



How Intel's Video Device Interface Works

1. Video for Windows sends the encoded data stream of compressed video to the video codec.
2. The codec queries the video driver to see if it supports VDI or checks to see if VDI is implemented as a separate driver. If there's no support for VDI, video is handled normally through VfW and the GDI. Otherwise, the codec queries the driver to see which VDI functions are supported (e.g., color-space conversion, color-keying, clipping, and scaling).
3. After determining which VDI functions are supported, the codec decompresses a video frame, opens a channel to the VDI/video driver, and hands off the appropriate tasks.
4. and 5. The VDI/video driver BitBlts the video frame onto the screen by directly addressing the video controller's frame buffer, bypassing the Windows GDI.

How Video for Windows Works Now

1. Video for Windows sends the encoded data stream of compressed video to the video codec.
2. The codec decompresses a video frame, converts YUV color to RGB, and sends it back to VfW.
3. VfW calls Windows GDI routines to handle such tasks as window management, clipping, and scaling.
4. The GDI sends the video frame to the video board's driver.
5. The video driver transfers the BitBlts to the video controller's frame buffer to display the frame on-screen.

BEAM MY FILES UP, SCOTTY

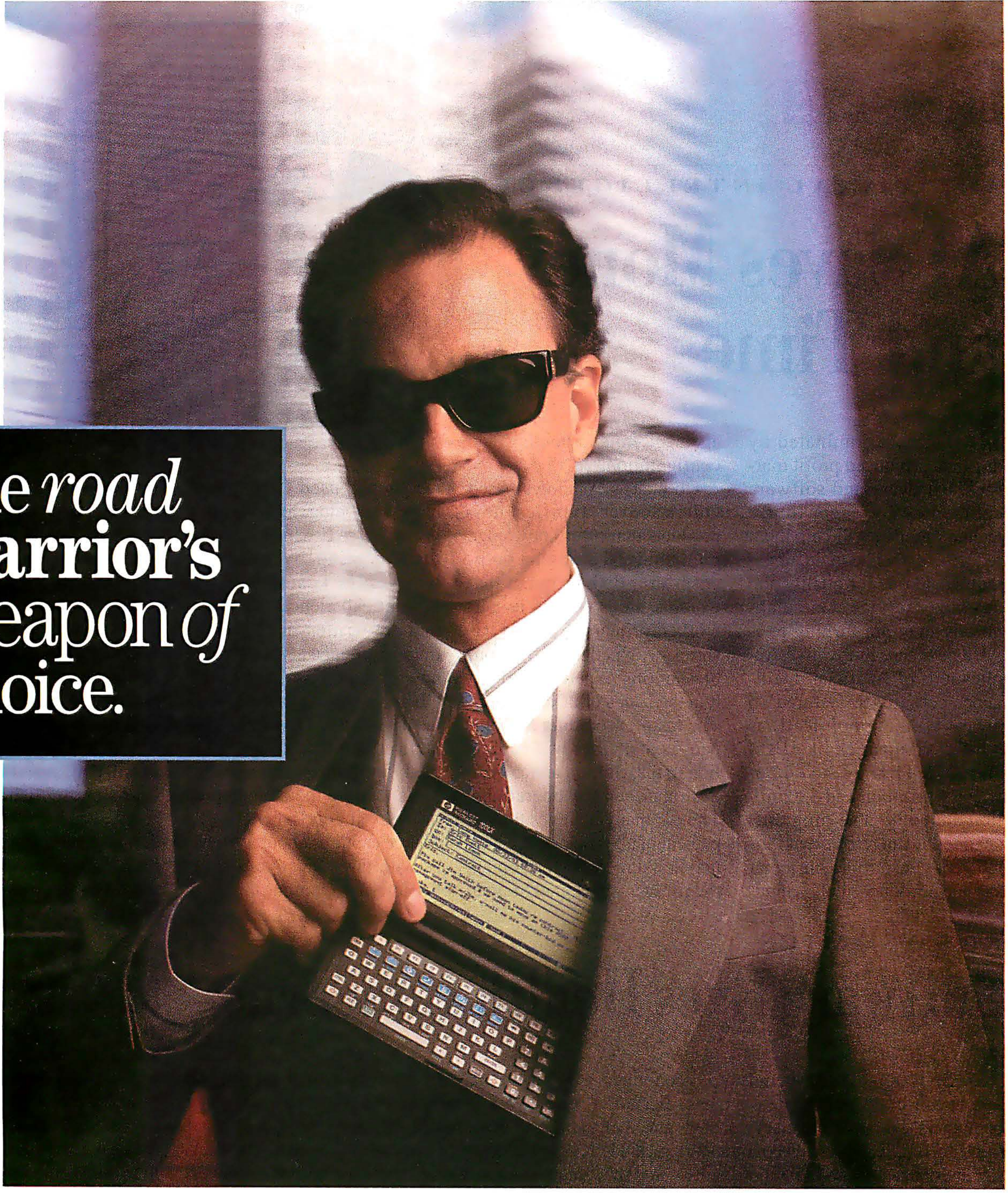
Infrared technology is poised to do for the office what it's done for the living room's entertainment center. Instead of being used to change TV channels, infrared light beams will make it much easier to exchange data between desktops, PDAs (personal digital assistants), and other devices. For swapping data to become as easy as changing channels, however, an infrared standard must be built into products from many companies. A nonprofit group called the InfraRed Data Association (IRDA) says it has a way to ensure that happens.

IRDA has agreed on a short-range, point-to-point standard for two-way infrared links. The group hopes these links will soon replace cumbersome cables for simple tasks such as moving a spreadsheet from your desktop to your laptop. IRDA's high-profile members include Intel, Microsoft, Apple, and Compaq.

Using infrared beams in place of cables is not new, of course. Infrared-leashed mice have been available for several years now, as have a handful of infrared-based LANs. Infrared has crept into newer products as well. But because they operate at different speeds and use varying protocols and data formats, they won't communicate with devices outside their immediate families. The new standard is expected to change all that. Based on the same technology already used in HP's products, the IRDA standard is a baseband system that zips along at 115 Kbps. HP's approach was chosen over competing systems from Sharp and General Magic due to its superior speed, circuit simplicity, low power requirements, and minimal cost, according to Steven Harris, an engineering manager at Crystal Semiconductor and chairman of IRDA's technical committee.

Whether or not there will be any provision for compatibility with previous infrared systems remains to be seen. Harris notes that it's possible to support the IRDA standard and a proprietary infrared system on a single chip. New products using the IRDA standard could begin appearing by the end of this year, with many more arriving in 1994.

—Christopher O'Malley



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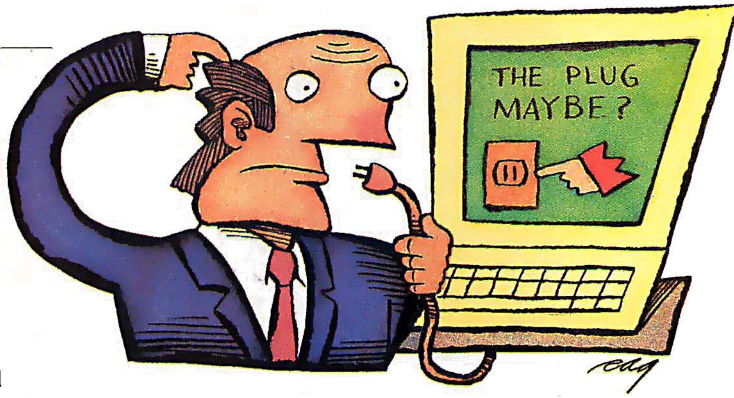
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AI Saves Money and Time



In a market dominated by drastically reduced profit margins, hardware and software companies are eager to use technology that will help them reduce costs while maintaining their standards for quality and customer service. One technology they are turning to is AI. The recent Innovative Applications of Artificial Intelligence conference featured 16 award-winning applications built at companies like IBM and AT&T. They saved between $1 million and $20 million annually. The programs spanned a range of areas: intelligent CASE tools, customer support, product quality management, troubleshooting, and configuration.

Compaq's Windows-based QuickSource typifies new products that offer knowledge publishing. Through a help-desk-on-a-disk program that Compaq ships with all its networked printers, Compaq has shrink-wrapped its staff's troubleshooting expertise and put it in the hands of its customers. The result, according to Compaq, is a savings of $10 million to $20 million annually in customer service operations. The company believes that 20 percent of all problems are now handled directly by customers themselves with QuickSource.

Compaq used CBR (case-based reasoning) techniques, a branch of AI, which enables programming by example. Knowledge is stored in the form of experiences, or cases, that are written in conversational-language style. When a new case is described to the CBR system, it retrieves similar past cases. This technique is proving valuable for help-desk applications, enabling users to store the expertise of its best specialists. QuickSource captures about 500 cases with three levels of detail: for internal Compaq use, for service providers/dealers, and for end users (printer customers). The system also includes rule-based reasoning, the hallmark of expert systems, to help focus the case searches.

Other companies with award-winning applications that use AI to save money include Nynex and IBM. Nynex, the Baby Bell serving the northeast U.S., has developed the Outside Plant Engineering and Resource Administration application, which assists more than 350 engineers in planning and installing sophisticated electronic equipment. Nynex reports a significant productivity gain and $5 million annual savings.

IBM's Diagnostic Yield Characterization Expert provides automated data interpretation and process diagnostics for semiconductor manufacturing. It looks at product quality and yield loss. The company says the program reduces diagnosis time from several hours to minutes. IBM estimates DYCE saves hundreds of hours per month of engineers' and technicians' time. In addition, early detection has saved additional products from being manufactured with a defective process. This has meant a savings of several million dollars.

Interest in AI declined after an initial flurry of interest in the middle 1980s. However, in today's highly competitive atmosphere, companies are looking for solutions that give them an edge over their competition. AI is proving to be one such solution. **—Sara Hedberg**

ERGONOMICS

Software Eyes Health Concerns

LONDON—When it comes to ergonomics and health issues regarding the use of desktop computers, Europe is often several steps ahead of the U.S. The Scandinavian countries' long-standing insistence on low-radiation monitors and the emergence of the EC's VDU directive that is now law in all member states exemplify a heightened awareness of how computers affect us.

The regulations and guidelines regarding the use of monitors in the workplace have created an opportunity for European software firms that develop products that help companies comply with the law. Two products focusing on eye testing on a user's machine and the wider implications of the EC's VDU law show that companies are taking advantage of the opportunity.

City Visual Systems (+44 71 837 3388) has released a product called Vision Screener. It makes use of a clause in the EC directive allowing optometric software to perform eye tests, with employee consent, on a user's machine. The software runs under Windows 3.1 and contains a series of tests aimed at spotting any eye problems experienced by the user.

Vision Screener does not replace the need for employers to arrange physical eye exams by a trained optometrist for employees. But it can help cut down on unnecessary testing. The package is also useful in charting a person's recovery from a VDU-related complaint after treatment.

The other Windows package is ErgAware from UserData (+44 71 243 2925). Through a question-and-answer process, the program assesses how well your company complies with European VDU health and safety provisions.

"There is a perception in Europe that everything must be more advanced in the U.S., but this is not really the case in ergonomics," says Chris Hunt, managing director of City Visual Systems. "The country [the U.S.] is so vast and has so many variations between state government and employer attitudes that things are fragmented, with no common guidelines." However, this state of affairs could change in the U.S. if regulations regarding the use of monitors in the workplace are attached to the U.S. Health and Safety Reform Act now wending its way through Congress. **—Dom Pancucci**

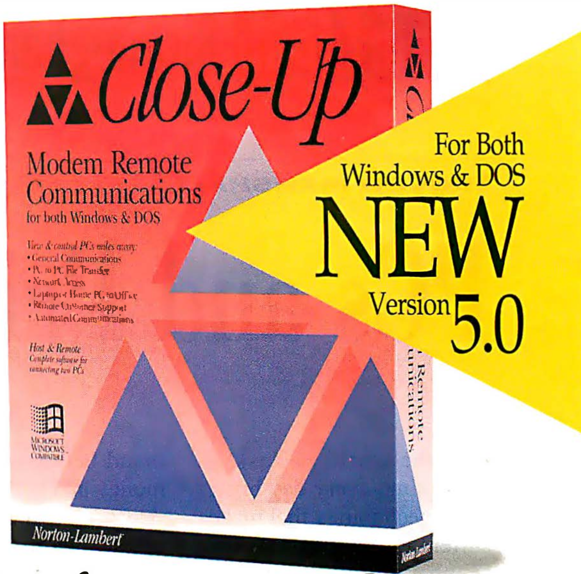


WinBench scores (average of 10 runs):
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WinBench™ 3.11 by Ziff-Davis Labs Tests Remote Windows™ Speed

This graph shows the speed of the three leading remote control programs when transferring Windows screens. As you can see, Close-Up handles more pixels, faster, meaning you spend less time waiting for Windows screens.

The industry standard test, WinBench 3.11, is perfect for testing the speed of remotes. It is an accurate measure of video throughput. Video throughput is the limiting factor in remote operations, because remote programs must transmit Windows video functions from one PC to the other.



New Remote Software Sets Windows Speed Record

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5. Video Translation

Why Is Close-Up So Fast?

Close-Up learns as it works. It uses AI (Artificial Intelligence) to compress all Windows video function calls. That's why Close-Up does so well in Windows Benchmark tests (see WinBench 3.11 chart).

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What Remote Companies Haven't Told You

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We invite you to reproduce this test. We used two identical Gateway 4DX2-66V's with 66-MHz Intel 486DX2-66 CPUs, 16 MB RAM, 256KB RAM cache, 340 MB HD, IDE controller, no hardware disk cache. Video: Local Bus ATI Ultra Pro with 2MB VRAM, 640 by 480 pixels, 16 colors, VGA.DRV dated 3/10/92. Monitor 72 Hz. MS-DOS 5.0, SMARTDRV 2 MB cache. Modems: two 14,400 baud V.32bis. WinBench 3.11 is available on ZiffNet accessible via CompuServe. Test performed without verification by Ziff. All products are shipping versions. WinBench trademark of Ziff Communications Co. Windows trademark of Microsoft Corp.

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TREVOR MARSHALL

PCs and Printing Plates

In the world of desktop computing, every day brings a new technology that makes current technology obsolete. Compared to the fast-paced world of desktop computing, the prepress industry changes at an almost glacial-like pace. But based on observations at the International Printing Exposition, or IPEX, it is clear that this industry has begun to fully embrace the computer.

"This industry has seen little change for decades," says Andrew Low of Genix Imaging, the London-based distributors for Cactus plotting systems. "But this show is totally different from the last IPEX. There were very few PC-based prepress computers at the last show, just a lot of mechanical printing presses. In the last five years, this industry has been thrust into the computing age, and many of the artisans and craftsmen are finding it difficult to cope with the new concepts."

Some major industry players are managing better than others to understand the dynamics of this new marketplace. Mitsubishi announced the formation of MC-Imaging, a company that will market Mitsubishi's prepress products worldwide, as well as those of other manufacturers; thus, it can provide customers with solutions tailored to their own requirements.

MC-Imaging has also decided to sell directly to the end user, bypassing the distribution channels that Mitsubishi has previously used. Company officials say the reason for the direct-sales effort is that its customers increasingly demand better value for their money and the expert advice that only a specialized prepress company can provide.

Brussels-based Dainippon Screen is also restructuring its operations. Roger Mattalon, Dainippon's European general manager, says the company now sells open systems. "If a customer wants to use Photoshop on a Mac or PC, we will not try to sell him our own proprietary solution but only those parts of it that he needs," Mattalon says.

The most interesting new technology at IPEX is called direct-to-plate printing. Currently, when a page has been prepared on a PC, it is transferred as a PostScript image to an imagesetter, which plots the page to high-resolution film. That film is then put into a photographic platemaker, and the aluminum plates that the printing press uses are exposed and etched.

Direct-to-plate systems let the actual plate material be created in the imagesetter, bypassing the inaccuracies inherent in the old process. Agfa Compugraphic demonstrated its Lithostar process, which creates aluminum plates that have a service life of 100,000 copies. Mitsubishi Paper Mills has Silver Digiplate, a lower-cost alternative in which the plates are made with paper or polyester substrates.

Although MPM's plates are good for only 20,000 copies, the media can be used in standard imagesetters and costs only about $1 per square foot. This system could considerably lower the current cost of short-run color printing.

Perhaps the most interesting direct-to-plate technology was shown at the NewGen booth. There, Plazer Ltd. (Tel Aviv, Israel) was generating printing plates using standard laser printers. In Plazer's new process, special polyester material is fed into a laser printer. A person then etches the resulting image using nothing more technical than cotton swabs of etch solution. The sheets were then put into a small Heidelberg T-Offset press, which can generate prints at an alarming rate of 10,000 copies per hour. Plazer says that the life of a typical plate is 15,000 copies. The product can be bought in the U.S. from Anitec. The cost of this polyester "plate" material is about $1 per square foot.



MANUEL KING © 1993



Direct-to-plate technology, a highlight of the International Printing Exposition, will bring printers into the digital age.

Plazer's new technology might give new meaning to desktop publishing, as you can run what would normally be a plain black-and-white image several times through the press to produce prints with color spots. The plazer film is also transparent, so it can generate screens for silk-screen printing.

Autotype International showed a laser platemaker system called NovaDom that is similar to Plazer's, but Autotype processes its plates in a toner-fusing machine prior to putting them in the press. The fuser costs $450. Autotype is more conservative, claiming that each plate will last for 5000 or so copies, as compared to Plazer's claimed 15,000-copy life. Both systems are capable of resolutions in excess of 1200 dots per inch.

At the last IPEX, which was held in 1988, heavy machinery represented 90 percent of the exhibit space. This year the electronic prepress exhibits have expanded to occupy nearly half the total floor space. What a difference five years make. ■

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Beauty And dBASE.

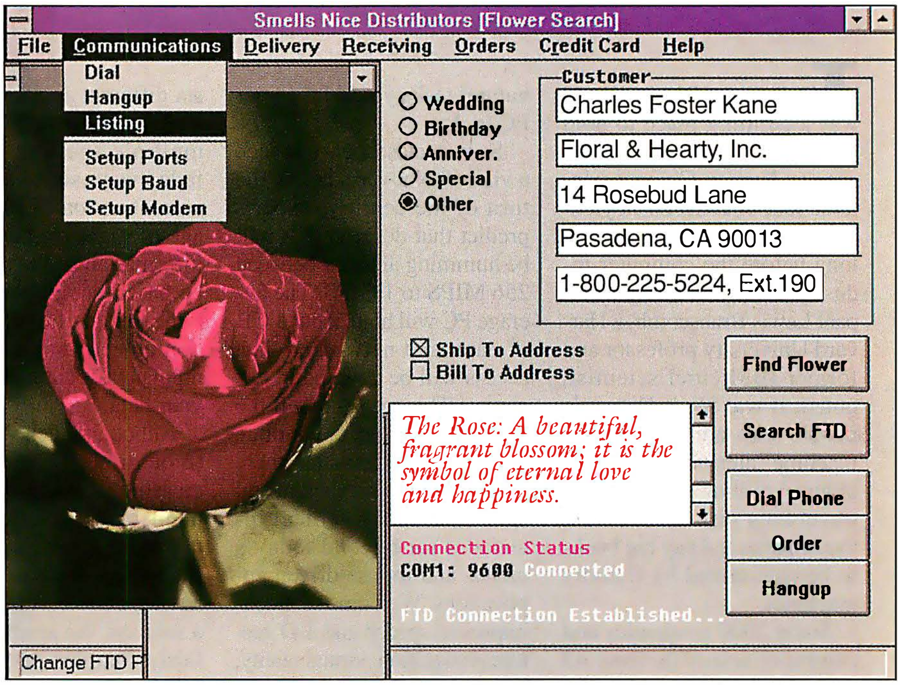


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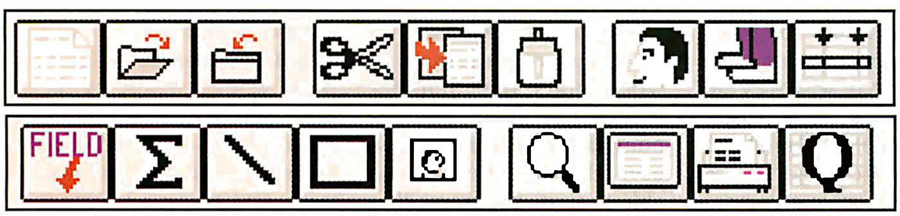
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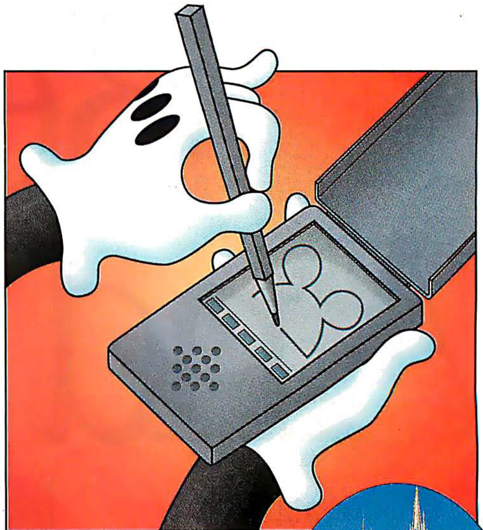
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RICH FRIEDMAN

Walt Disney Knew a Good Interface





Experts in human-computer interaction predict computers will play a much more active role, taking the GUI far beyond today's point-and-click method of interaction.

The home of Disney World was a befitting place to hold the 5th International Conference on Human-Computer Interaction, or HCI. Disney engineers believed in multimedia long before the computer industry. As conference participant Lewis Branscomb, a Harvard University professor and former IBM chief scientist, noted, it was Walt Disney's people who created human-machine interfaces that have induced millions of people to travel long distances to visit theme parks and pay big bucks to be entertained by friendly machines.

Some 2000 academics and computer scientists from 43 countries came to the city Disney built to exchange ideas and research notes on how to make computers easier to use during the next 10 years. Several presenters showed or referred to that deceptively simple Knowledge Navigator video that Apple produced in 1987 to demonstrate what kind of computers we might be using in the future.

In the Knowledge Navigator video—set half jokingly in the "era of the 40-minute work week"—a young professor tells his computer, which looks like a small flat notebook, to rearrange his schedule, converse with a colleague, search disparate databases for "a certain paper that was written about two years ago on the effect of logging on the Amazon rain forest," and perform other perfectly natural tasks you'd love your PC to do.

So how close are we to such a vision? Not very, but by the turn of the century, experts predict that desktop PCs will be humming along at between 256 MIPS to 1 GIPS. The average PC will hold about 4 GB of data, and networked data access will be counted in terabytes. This means that if the hardware engineers continue to extract their miracles, there will be enough bandwidth and speed to take graphical interfaces far beyond today's menu- and mouse-driven applications. Welcome to much-improved speech and 3-D gesture recognition, virtual reality, agents, and eye tracking.

Jakob Nielsen, a research scientist at Bellcore in Morristown, New Jersey, who gave a day-long seminar on next-generation user interfaces, believes that future computers will play a much more active role in terms of what they present on their screens to users. For example, a PC might automatically change the size of a screen font to accommodate a user who sits further away from the screen. Object-oriented software will let the document, rather than the applications that created it, become the primary focus of the user's attention. In fact, plug-and-play software modules will replace applications altogether, thus eliminating, for example, the need to store—and use—six different spelling checkers that come with six different applications.

According to Nielsen, as multiple spelling checkers fade away, so, too, will our current notion of files. In the age of gigabyte hard drives, information retrieval will not be based on simple files but rather on interlinked information objects that let you manipulate associations between your data.

Although much work is yet to be done, agents will increasingly anticipate a user's needs and take over many tasks of operating a computer. If an agent senses that a user is having trouble, it can suggest a solution. An agent can learn fairly complex patterns, forward data to various locations depending on where a user is, and even, in some circumstances, DWIM (do what I mean) instead of DWIS (do what I say).

With its increased ability to recognize patterns and work habits, the computer will take on more programming tasks. By observing a user, the computer will be able to write programs that automate such behavior in the future. This will be more far-reaching and universal than the arcane scripting and macro languages contained in present applications.

Everyone's question, of course, is, When will the next-generation interfaces happen? Some are already in use, such as pen and voice recognition, but they are handicapped by today's hardware limitations. Researcher Nielsen does not believe we will have a very practical next-generation interface before the year 2000. He says that the hardest hurdle to overcome will be standards for advanced data interchange and system integration.

In 1986, a group of Danish computer professionals was asked how computer interfaces would change by the year 2000. A third mentioned speech I/O; 16 percent cited the increased use of graphics, mice, and icons; 12 percent thought the "system would adapt to the user's level," and 7 percent thought we would progress to the point of self-explanatory systems and eliminate the need for manuals. Yet an equal number believed "the past will survive."

COBOL lives. ■

Rich Friedman is BYTE's executive editor. You can reach him on BIX as "rfriedman."

INTEL TECHNOLOGY BRIEFING



INDEO™ TECHNOLOGY
REAL-TIME VIDEO COMPRESSION

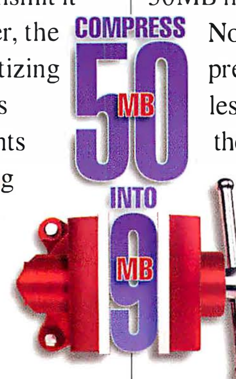
Desktop Video. Now Playing On Your PC.



Indeo™ video is a digital video recording format. It turns your PC into a video player, so you can view training tapes, recorded interviews and other digital "movies." With the appropriate hardware, it also turns your PC into a video recorder. In this brief, you'll learn about the technology behind the motion.

Why digital video?

Due to its versatility, digital video has several advantages over analog video. You can edit it, store it, and transmit it easily. However, the process of digitizing video generates massive amounts of data, creating a storage problem. That's why you need Indeo video.



Indeo Technology defined.

Developed by the Intel Architecture Labs, Indeo video is a software technology that reduces the size of uncompressed digital video files from 5 to more than 10 times. This is important, because a one-minute small-screen video file is typically 50MB, but it can reach hundreds of megabytes. On average, Indeo video will reduce this 50MB file to about 9MB. Not only do compressed files take up less hard disk space, they also process faster, giving you better quality playback.

How do you get Indeo video? It's included free in products like Video for Windows,* OS/2* and QuickTime* (Mac and Windows).

What makes Indeo video "Smart?"

Indeo Technology has essentially three unique benefits:

Smart playback.

Indeo Technology is scalable. That is, it automatically determines what hardware is available and optimizes playback for that configuration. For example, it will give faster frame rates to machines with more processing power. As shown in the chart on back, good quality video can be achieved with an Intel486™ DX2 processor. A Pentium™ processor gives even better quality.

Smart recording.

To get the best quality playback, you must first capture as much video data as possible during the recording process. Currently, Indeo video allows capture in a 320x240 pixel window at 15 frames per second with 24-bits of color. This ensures good quality when video is played back in larger windows.

A unique feature of Indeo Technology is that it compresses video in real time, as it's being recorded through a video capture board. So the file doesn't have to be saved to the hard disk then later compressed—a process which can take up to 15 to 30 minutes per minute of video and requires massive storage capacity.





Smart compression.

Only Indeo video uses multiple types of "lossy" and "lossless" compression techniques. (See diagram this page.) With lossless compression, no information is lost. It is instead encoded into a format that occupies less space. Lossy compression carefully removes from video images "excess" data which won't be noticed by the human eye. This affords greater compression ratios, and hence better playback performance.



How to record and play back video using

Indeo™ Video Technology

Video recording.

1 Input and conversion. Analog video is received from a video camera, VCR or laserdisk in any standard format such as NTSC (broadcast TV). A video capture board—such as the Intel Smart Video Recorder—converts this analog video signal into digital information.

Video playback.

Indeo video lets you play back a video file regardless of whether or not you recorded it. Before the file can be viewed, it must first be decompressed. Indeo video reverses the compression process, reassembling the video information on the i486 microprocessor—again in real time. Since Indeo Technology is scalable, it automatically adapts playback (frame rate) to the hardware it is running on.



2 Single-step compression. After the video is digitized, Indeo video, running on the i750 video processor, compresses it in real time, utilizing the following:

Indeo video compression techniques.

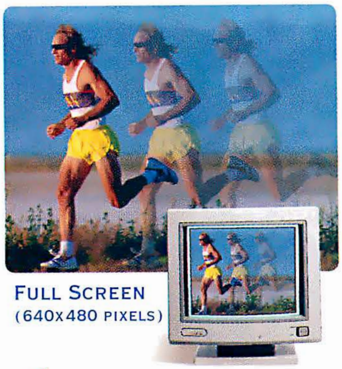
- YUV Subsampling reduces a pixel area to an average color value
- Pixel Differencing and Temporal Compression shrink data by storing only the information which changes between pixels or frames, like a moving image
- Run Length Encoding notes a "run" of identical pixels and records how many occur
- Variable Content Encoding reduces a variable amount of information into a fixed number of bits.

3 Storage. Once compressed, the digitized video file is then combined with the audio information into a standard file format, such as Microsoft's Audio Video Interleave (AVI), and stored to a hard disk. Now the file is ready for use, i.e. playback, editing, distribution or storage on disk or CD-ROM.

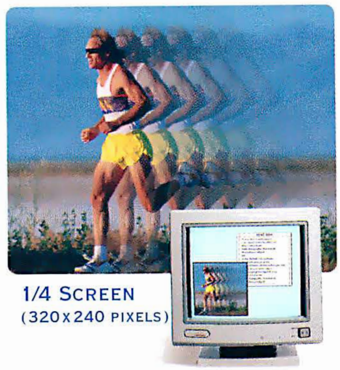
Factors That Affect Video Quality

Window Size vs. Frame Rate

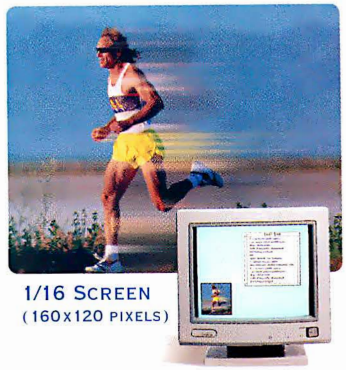
Slow Frame Rate → Fast Frame Rate



Full Screen
(640x480 pixels)



1/4 Screen
(320x240 pixels)



1/16 Screen
(160x120 pixels)

Large Window ← Small Window

Microprocessor Performance

Processor**	Full Screen	1/4 Screen	1/16 Screen
i486 SX-25	~1 fps*	15 fps	30 fps
i486 DX2-66	10 fps	30 fps	30 fps
Pentium Processor	20 fps	30 fps	30 fps

*Frames Per Second. **Frame rate based on playing an Indeo video file captured at 30 fps. These are typical numbers only. The frame rate may vary based on system configuration and the video clip being used.

Factors that affect video playback. There are essentially three factors that affect video performance:

- Microprocessor speed
- Playback window size
- Frame rate

Smaller playback windows result in smoother, more natural video images. A faster microprocessor supports bigger playback windows and higher frame rates.

Intel Video Advancements.

There are three ways in which Intel is continuing to improve desktop video. First, faster video starts with faster computers, so we're developing faster CPU technology. Second, we're working with leading graphics card vendors to optimize their software drivers for Indeo video. And finally, we're developing more efficient compression and decompression (codec) techniques to give video higher quality. All of which will help you understand why Intel and Indeo Technology mean higher-quality video.

How do I get Indeo video?

Indeo video is included in most operating systems, so you get it free. Additionally, most leading software developers are using Indeo Technology to add video capabilities to their applications, because of its high quality and interoperability between different platforms. So you can interchange video files between operating systems—even between PCs and Macs. Look for the Indeo video logo whenever you buy multimedia hardware and software.

indeo™ Intel Video Technology

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Big Blue Tales



ANDY REINHARDT

No matter how closely you've followed the inexorable decline of IBM over the last few years, or how voraciously you've devoured every revelation in the public and bitter "divorce" between IBM and its erstwhile ally Microsoft, you're bound to find new and fascinating details in *Big Blues: The Unmaking of IBM* by *Wall Street Journal* reporter Paul Carroll. Densely researched and richly detailed, it chronicles the fall of IBM, from the heady highs of the early 1980s—when the company posted a $6.6 billion profit in a single year, the most ever earned by any corporation—to the nightmare of 1993, when IBM ousted its chairman, broke its policy of no layoffs to jettison thousands of workers, and posted the largest corporate loss ever recorded.

Carroll covered IBM for seven years for the *Journal* and was especially admired for the quality of his sources. He minces no words in analyzing the factors that led to IBM's fall: thick layers of bureaucracy, excruciatingly slow development cycles, a mainframe mentality and lack of vision about the PC market, an inability to deliver good software, and, most of all, rampant complacency that obscured how bad things had really gotten.

The fast-paced narrative is full of juicy anecdotes; some have appeared elsewhere, but many more are published here for the first time. Carroll's access and knowledge are evident throughout. He covers a huge range of subjects, from the underlying trends that have shaped and altered the computer business over the last two decades, to the personalities of key executives inside and outside IBM, to fly-on-the-wall descriptions of key battles in the long-simmering feud between IBM and Microsoft.

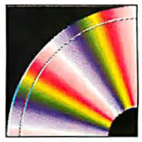
Indeed, the strongest aspect of *Big Blues* is its anecdotes. Carroll reveals, for example, that IBM tried and failed to create a custom version of the 286 that would fix the chip's inability to switch from protected mode back into real mode. He also discloses that Lotus founder Mitch Kapor tried and failed to interest IBM in an exclusive marketing deal for 1-2-3. The latter is one of dozens of examples Carroll cites of opportunities squandered by IBM.

I found especially interesting the discussion of the "bus wars" of 1989, in which Carroll concludes that with the PS/2's Micro Channel architecture, "IBM had staked the future of its PC business on an irrelevancy." Another fascinating section is his description of the events leading up to the fateful 1989 Fall Comdex press conference in which IBM and Microsoft tried to clarify the relationship between OS/2 and Windows and succeeded only in confusing the market.

The book's main weakness is that its assessment of IBM may prove to be too unremittingly harsh. Carroll subjects the company and many of its executives to breathtaking criticism; those especially mauled are former chairman John Opel and former PC division head Bill Lowe, whom Carroll describes repeatedly as wooden and upon whom he heaps the most blame for IBM's PC market-share loss. Carroll accords most favorable treatment to Don Estridge, the head of the IBM PC skunk works, who was killed in an airplane crash in 1985. Microsoft chairman Bill Gates comes off surprisingly well, a notable change from the pasting he has taken in a wave of recent biographies.

The book's organization varies between chronological and thematic, which introduces redundancy and sometimes confuses the order of events. Readers who are not well versed in computer technology will appreciate how clearly Carroll explains basic concepts, but sometimes his lack of technical detail obscures the meaning of events, such as the battle between IBM and Microsoft in mid-1986 over whose GUI architecture should be used on top of OS/2.

Carroll's writing suffers from a problem common among newspaper-reporters-



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This powerful research tool, built around a customized version of Microsoft's Multimedia Viewer, is an information gold mine for the professional software developer. One section presents technical articles that address a wide range of questions: How do I use the DLL version of the Microsoft Foundation Classes? How does the SQL Server query optimizer work? How can my program exploit the Windows palette manager? Microsoft programmers answer these questions with surprisingly literate prose, diagrams, and sample code.

Another section presents nothing but code samples. You can view and in many cases run these programs directly off the CD. When you want to tinker with them, you can just click on a transfer button to move the complete sources onto your hard disk.

A third section presents the full text of a number of key specifications, including those for NDIS, DPMI, MAPI, ODBC, Windows Sockets, and Windows Telephony. A fourth section contains technical notes and bug reports for nearly 40 products, including Visual C++, FoxPro, MS-DOS, and various SDKs and DDKs. Almost all entries include illustrative code fragments. Bugs still outstanding are so noted, and workarounds (if available) are described.

A fifth section offers books and periodicals, notably classics on DOS and Windows programming by Charles Petzold and Ray Duncan and the *Microsoft Systems Journal*. A sixth section contains documentation for products such as the MSCDEX DDK, the Excel SDK, and the Windows 3.1 DDK and SDK, along with the Windows 3.1, Windows for Workgroups, and Windows NT resource kits. If your livelihood depends on Microsoft's growing family of operating systems, programming tools, and applications, you probably can't afford not to subscribe.

—Jon Udell

turned-authors: a tendency to rely too much on stories strung together with generalizations and foreboding phrases. Thus, describing IBM's decision to pull the PC group back into the corporate structure, he says, "The move would not only doom IBM's PC business but would eventually put Don Estridge on a plane that would cost him his life." (The millions of IBM PCs and PS/2s sold since then suggest that the business was far from doomed.) The glibness reaches a peak in Carroll's frequent assertions that mainframes are dinosaurs and OS/2 is a failure, before the final verdicts have been rendered.

Although he doesn't offer a unique or especially profound analysis of the recent history of IBM, Carroll's story-telling skills justify reading *Big Blues*. If you're hungry for a peek inside the walls of IBM, you'll soak up every page.

BIG BLUES: THE UNMAKING OF IBM
Paul Carroll
Crown Publishers
ISBN 0-517-59197-9
$24

Andy Reinhardt is BYTE's West Coast bureau chief. You can reach him on BIX as "areinhardt."

CLONING TRENDS

TECHNOTRENDS by Daniel Burrus and Roger Gittines
HarperCollins, ISBN 0-88730-627-6, $25

In 1982, John Naisbitt's *Megatrends* launched a new subgenre of business books with a formula that was simplicity itself: Identify a handful of major trends, sketch out each n a highly structured chapter, and pitch the result to baby-boomer corporate business managers looking for a road map to the future. *Megatrends* wasn't so much a book to read as it was a database to access. Naisbitt's 30-something audience could pick up the buzzwords from the subtitles, dig a little deeper by scanning chapter introductions and boldface keynote paragraphs, and check out his statistics and other evidence at leisure. Not surprisingly, clones of *Megatrends* soon started rolling off the presses. Naisbitt even copied his own success in *Megatrends 2000* (which included a prediction that there would be no recession in the 1990s).

At first glance, Daniel Burrus's *Technotrends* seems to come from the same genetic heritage, albeit with a high-tech spin. The cover blurb promises "24 technologies that will revolutionize our lives." Pen-based and multimedia computers top the list, but that's just the start. Burrus identifies 20 core technologies, nine revolutions new products will create, 30 rules for leveraging new technology ("If it works, it's obsolete"), and nearly 100 paradigm shifts. If the genetic code for a *Megatrends* clone calls for a short list of memorable trends identified by buzzwords, *Technotrends* resembles a recombinant DNA experiment run amok.

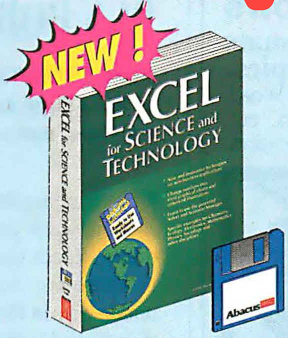
Burrus is clearly no management pundit distilling the future into a simple road map. He's not a technologist, either; most BYTE readers won't learn anything new from the discussions of object-oriented programming and distributed computing. Burrus's goal is to get readers thinking about how all these products, technologies, revolutions, and trends fit together—and how ordinary people can create business advantages from technological change.

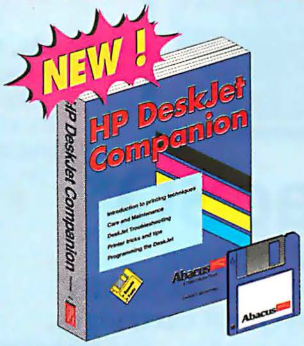
Unfortunately, the book's dialogue is sophomoric. And while Burrus's thoughts are wide-ranging, they never go very deep.

—Frank Hayes

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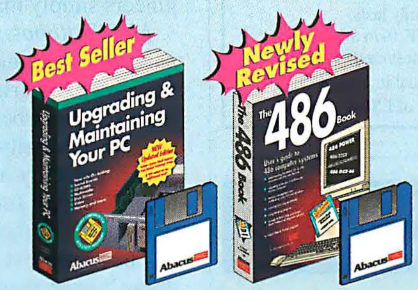
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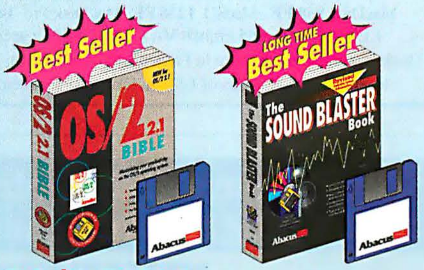
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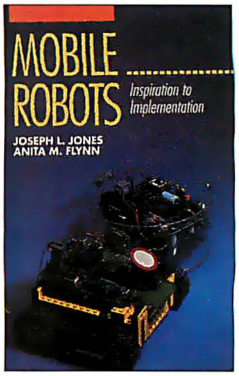
RUN ROBOT RUN

MOBILE ROBOTS: INSPIRATION TO IMPLEMENTATION
by Anita Flynn and Joseph Jones
A. K. Peters, ISBN 1-56881-011-3, $39.95

Imagine a robot in your future. It will clean the house, walk the dog, wash your car, and take out the trash. Well, dream on, but don't expect reality to catch up with fiction anytime soon.

There are, however, extremely interesting projects currently under way in the robotics field: interplanetary explorers, deep-sea divers, and automated toxic-waste cleanup crews. In my opinion, one of the most interesting trends in robotics is the move away from the design of giant, all-powerful robots toward developing groups of small, special-purpose machines. It's the approach of trying to build ants rather than anything even as complex as a chimpanzee.

Another trend is the separation of intelligence from intelligent behavior. As long as a robot does what you want it to do, why bother wondering whether or not it's really intelligent? Leave that for the theorists and scientists. Engineers simply make things that work.



Mobile Robots: Inspiration to Implementation is a handbook for constructing your own experimental robots. These machines may be constructed of Legos and other equally inexpensive components, but they are more than simply toys. They are fully functioning robots with minds of their own.

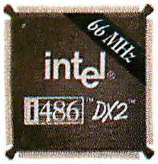
The simplest machine, TuteBot, doesn't even require a microprocessor. Its programmable, exploratory behavior is controlled by a few transistors and potentiometers. Yet, even being brainless, it can explore entire rooms, wandering into remote corners and extricating itself for further exploration. Believe me, a roomful of these little critters is pure entertainment.

Rug Warrior is the more complex machine, complete with an on-board 68HC11 processor and software based on subsumption architecture. The subsumption approach to robotics is the simple yet elegant concept that behavior should be composed of increasingly complex levels of control. For example, a low-level behavior may simply know how to move a leg. A middle-level behavior could know about gaits. A high-level behavior could say, "Let's go through that door."

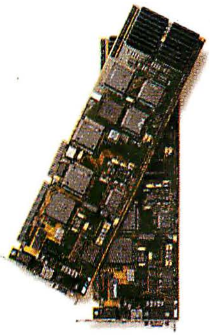
Flynn and Jones provide more than just step-by-step plans for constructing these robots. They include the basic mechanical, electrical, and software background for making it all work, and for designing your own machines. You'll find chapters on real-time control, types of sensors and how to control them, motor dynamics, battery recharging, and the design of stable systems. Appendixes provide complete plans for a 68HC11 control computer, a parts source book, and a list of current robot-related publications (it even references my own newsletter).

Whether you are a serious explorer intent on creating a future world populated with robot devices, or simply a backyard hobbyist building machines to frighten the neighborhood cats, you'll find *Mobile Robots* an indispensable handbook. ■

—Raymond GA Côté



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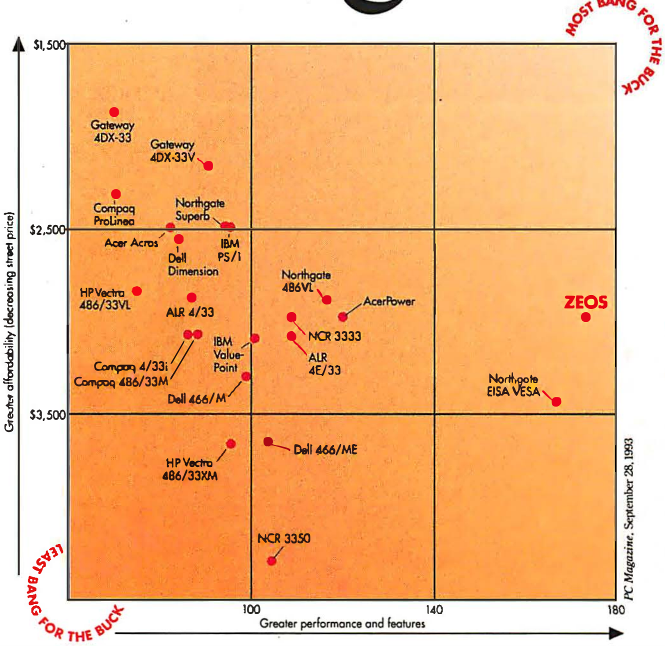
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- 256K SRAM system cache
- 528MB local bus IDE hard drive
- Diamond Viper/VLB local bus video card with 1MB VRAM
- 1.2MB and 1.44MB floppy drives
- 15" ZEOS color SVGA non-interlaced monitor, .28mm dot pitch
- MS-DOS 6 with Enhanced Tools, Windows, and new Microsoft Mouse, plus choice of Lotus Windows applications
- 14,400 bps V.32 bis send/receive fax modem
- SAME DAY SHIPPING

Others pale in comparison. There's no way to dispute it! The results are in, and the ZEOS Upgradable 486DX2-66 is "the overall performance winner."

PC buyers expect low prices, top-quality, impeccable performance and prompt support. Basically, they want the most bang for their buck. *PC Magazine* recognized this and compared value-line PCs with more traditional systems to see if they were "truly good values or stripped-down machines trying to pass for good buys." The results are overwhelmingly in ZEOS' favor. In fact, *PC Magazine* said:

"ZEOS doesn't sell a separate value line, but the flexibility of its main system may be the least confusing solution of all."

Stacked against Gateway, Dell, Compaq, IBM and others, ZEOS stood alone. Using the Benchmark Tests as a guide, *PC Magazine* made these conclusions:

"As DOSmark scores are heavily weighted for processor and hard disk performance, the ZEOS garnered the first-place position in that category as well."

"The clear winner is...the ZEOS Upgradable, which turned in an incredible score of 55.01 megapixels per second."

"The real highlight among tested hard disks was the Seagate ST3600A, which has 12-ms access time and 256K of built-in cache. The ZEOS 486DX2-66 Upgradable's hard disk performance was almost 31 percent above the average in this roundup."

Of the *"systems that demonstrated the best agility under strenuous exercise of all their components... ZEOS (scored) 26 percent above average."*

The ZEOS local bus upgradable systems are the perfect solution—the brand-new motherboard is faster, more integrated, versatile and reliable than ever. Plus, ZEOS is always thinking ahead to your

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- Flash BIOS for easy upgradability.
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- Shadow RAM support.
- ZEOS 101-key space-saving keyboard.
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- Complete ZEOS Customer Satisfaction Package.

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486SX-33	$1495 Lease $63/month	$1795 Lease $65/month	$2095 Lease $76/month	$2595 Lease $94/month
486DX-33	$1695 Lease $61/month	$1995 Lease $72/month	$2295 Lease $83/month	$2795 Lease $101/month
486DX2-50	$1795 Lease $65/month	$2095 Lease $76/month	$2395 Lease $87/month	$2895 Lease $105/month
486DX2-66	$1895 Lease $69/month	$2195 Lease $79/month	$2495 Lease $90/month	$2995 Lease $108/month
	■ ZIF socket upgradability to Pentium OverDrive CPU	■ ZIF socket upgradability to Pentium OverDrive CPU	■ ZIF socket upgradability to Pentium OverDrive CPU	■ ZIF socket upgradability to Pentium OverDrive CPU
	■ 2MB high-speed RAM	■ 4MB high-speed RAM	■ 8MB high-speed RAM	■ 16MB high-speed RAM
	■ 107MB local bus IDE hard drive w/32K cache	■ 214MB local bus IDE hard drive w/128K cache	■ 426MB, 13ms local bus IDE hard drive w/128K cache	■ 528MB, 12ms local bus IDE hard drive w/256K cache
	■ Diamond SpeedStar Pro Windows-accelerated VL local bus video with 1MB RAM. 16.7 million colors.	■ Diamond SpeedStar Pro Windows-accelerated VL local bus video with 1MB RAM. 16.7 million colors.	■ Diamond SpeedStar Pro Windows-accelerated VL local bus video with 1MB RAM. 16.7 million colors.	■ Diamond SpeedStar Pro Windows-accelerated VL local bus video with 1MB RAM. 16.7 million colors.
	■ ZEOS 14" 1024 x 768 N1 SVGA color monitor, .28mm dot pitch	■ ZEOS 14" 1024 x 768 N1 SVGA color monitor, .28mm dot pitch	■ ZEOS 14" 1024 x 768 N1 SVGA color monitor, .28mm dot pitch	■ ZEOS 14" 1024 x 768 N1 SVGA color monitor, .28mm dot pitch
	■ Your choice of floppy drives	■ Both 1.2MB and 1.44MB floppy drives	■ Both 1.2MB and 1.44MB floppy drives	■ Both 1.2MB and 1.44MB floppy drives
	■ MS-DOS 6 plus Enhanced Tools	■ MS-DOS 6, Tools, Windows & new Microsoft Mouse, plus choice of Lotus Windows application	■ MS-DOS 6, Tools, Windows & new Microsoft Mouse, plus choice of Lotus Windows application	■ MS-DOS 6, Tools, Windows & new Microsoft Mouse, plus choice of Lotus Windows application

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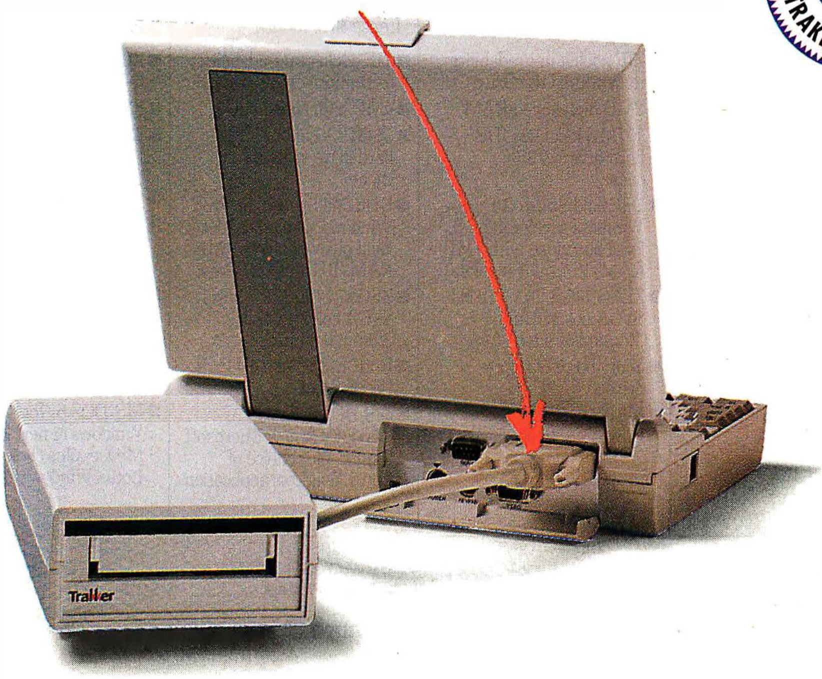
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Get Your Kicks with Switched 56

DANIEL M. JOFFE



JAMES YANG © 1993

Data communications can never be too fast or too cheap. This is especially true for demanding tasks such as internetwork communications, where vast amounts of data are exchanged on a constant basis. Using even the fastest available modems for this task can be slower and more expensive than you might like.

PC users battling the spiral of file sizes and LAN traffic are becoming aware of a digital telephone data-transport service called Switched 56. Every local and long-distance telephone carrier in the U.S. offers Switched 56 digital service. It is a digital, dial-up data channel with speeds of 56 Kbps synchronous or 57.6 Kbps asynchronous.

Although installation costs are higher than for analog service, Switched 56 usage charges are basically the same as for POTS (plain old telephone service). This means that you can save time and money with Switched 56 by shipping more data in much less time. At 9.6 Kbps, a modem takes 90 minutes to send a 5-MB file. The same file at 57.6 Kbps takes 15 minutes; assuming a long-distance call costs 25 cents per minute, you save $18.75 each time you transfer a 5-MB file at the faster rate. Even modems running at 24 Kbps and higher do not provide the speed and value of Switched 56.

Switched 56 offers a happy middle ground in price and performance for high-speed data communications

Needy Applications

Switched 56 got a boost with the advent of low-bandwidth videoconferencing. The digital service made it possible to send acceptable sound and pictures using only 112 Kbps, or two Switched 56 lines. As a result, every major videoconferencing manufacturer today has embedded Switched 56 in its equipment.

In publishing, Switched 56 is used to transport high-resolution image files to and from editorial offices. And in medicine, Switched 56 has been tested as a way to send dental x-rays to health insurers for preapproval of procedures or to consulting specialists for examination.

People who work at home with remote connections to LANs—an increasing population—find that 9.6 Kbps can be painfully slow. As a result, some companies use Switched 56 to connect home machines to office LANs.

Switched 56 is growing as a tool for LAN internetworking. Until recently, LAN routers were linked by dedicated digital lines running at speeds of 56 Kbps to full T1, if traffic warranted, or by dial-up 9.6-Kbps modems. But full-time leased lines are expensive, while the performance penalties of 9.6 Kbps drove organizations to dedicated digital lines even with light traffic.

With Switched 56, LAN routers automatically dial remote locations in response to requests for data from remote servers. To accomplish this, router and Switched 56 CSU/DSU (channel service unit/data service unit) vendors have standardized on V.25bis

TELECOMMUNICATIONS SERVICES COST COMPARISON

Although it can cost significantly more in installation and monthly fees for a Switched 56 line than for a POTS line, per-minute connect charges are almost the same. This could save money considering the speed of Switched 56. The business daytime line rates shown here are quoted from Ameritech, Nynex, and Pacific Bell. Per-minute rates are based on AT&T interexchange rates.

	NEW YORK	NY TO SF	SAN FRANCISCO	NY TO CHICAGO	CHICAGO
POTS					
Installation	$270		$155.75		$165.50
Monthly	$23.11		$11.85		$13.35
Per minute		$0.25		$0.23	
Switched 56					
Installation	$532		—*		$750
Monthly	$82.35		$39.65		$83
Per minute		$0.264		$0.245	
Dedicated 56 Kbps					
Installation		$1851.08		$1976.61	
Digital 56 Kbps					
Monthly		$1645.93		$903.85	

* Fee waived for 24-month commitment.

as the synchronous dialing-command language. V.25bis is to the synchronous world what Hayes AT commands are to asynchronous users. With V.25bis capabilities, a router can dial anywhere using the same path over which synchronous data is transferred. In the asynchronous world, PC users can turn to 57.6 Kbps asynchronous with AT-compatible dialing to speed their data transfers. And since many Switched 56 CSU/DSUs provide a subset of the Hayes Standard AT command set, PC users do not need to change existing software.

Speed on Demand

Switched 56 is bandwidth when you need it. You only pay for the connection time. Analog modems offer the same capability but not the speed of 56 Kbps, nor the 99 percent error-free transmission accuracy guaranteed by the telephone company. The switched or usage-sensitive nature of the channel delivers powerful bandwidth-on-demand capability that opens up a new range of applications that dedicated channels made cost prohibitive and analog alternatives made too slow.

Just as a modem provides the data interface to a standard analog phone line, a CSU/DSU provides the data interface to a Switched 56 digital phone line. Switched 56 calls are dialed and handled in much the same way as regular telephone calls. Each Switched 56 line is assigned a telephone number that you can dial like any POTS line. The CSU/DSU automatically handles all telephone company maintenance requests and changes the digital line format to a format compatible with DTE (data terminal equipment). A CSU/DSU has a street price of about $1000—less than some V.Fast modems. You do, however, need a CSU/DSU at each end of the connection.

Switched 56 replaces the local analog access line with a local digital access line and extends digital capability to a home or business. The combination of Switched 56 access lines and CSU/DSUs keeps the signal from your DTE in digital format from start to finish as it travels through the telephone company's digital network. In contrast, to transmit data using an analog modem, the modem converts your computer's digital signal to analog format, and then A/D converters residing in the central office reconvert the signal to digital. The corresponding series of conversions and related signal degradations occur again at the central office and modems on the receiving end.

Moreover, Switched 56 lines maintain independent transmit and receive paths, making the transmission faster and cleaner. In analog transmission, transmit and receive directions are combined onto the one pair of wires running between your home and the central office. The analog modem has to separate these directions, causing additional delays and potential for errors.

Switched 56 offers true 57.6-Kbps asynchronous speed for PC-to-PC file transfers. "True 57.6 Kbps" means 1-MB file transfers in just under 3 minutes (assuming 8 bits, no parity, 1 stop bit, and an efficient file transfer protocol). You can send even compressed files that fast.

How do you transmit 57.6 Kbps over a 56-Kbps line? Each asynchronous 57.6-Kbps character is burdened by 1 start bit and 1 stop bit. The meat of the character is the remaining 8 data bits. The Switched 56 CSU/DSU transmits only these 8 data bits using a more efficient way to mark the beginning and end of groups of characters—flag patterns similar to HDLC (high-level data-link control).

BBSes and services like CompuServe typically store large files in compressed format. Compression algorithms such as V.42bis, the CCITT data compression standard used on analog modems, do nothing to speed transfer of already-compressed files. So a V.32 modem with a DTE interface set to 57.6 Kbps can provide a maximum throughput of only 960 characters per second. In contrast, real 57.6 Kbps provided by Switched 56 allows a maximum throughput of 5760 cps, regardless of whether the file was compressed.

PC-Compatible

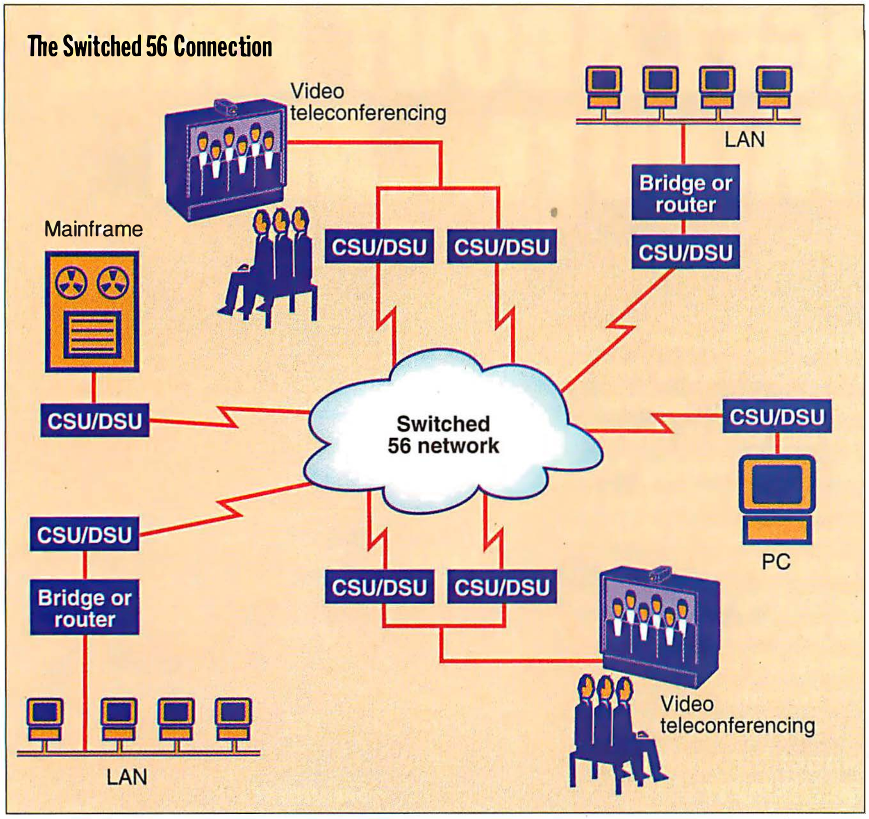
Some PCs cannot keep up with true 57.6-Kbps speed; it depends on the IC that's being used for the asynchronous serial-port UART (universal asynchronous receiver/transmitter) chip. PCs originally came with 8250 UARTs and later changed to 16450 UARTs. Both chip families share the shortcoming of 1-byte transmit and receive buffers.

With a single-byte buffer at 57,600 bps, the CPU must collect the next byte every 174 microseconds or risk having it overwritten. The "missing" byte would be detected by the communications program's file transfer protocol, and this would result in multiple block retransmissions,

COST-JUSTIFYING SWITCHED 56

Based on installation, monthly, and per-minute fees, Switched 56 becomes more cost effective than using a modem on a POTS line or a dedicated high-speed line. This table shows at which point, measured in megabytes of data transferred per month, Switched 56 starts to save money

	MEGABYTES PER MONTH FOR		
	9.6-KBPS MODEM	14.4-KBPS MODEM	DEDICATED 56 KBPS
New York to Chicago	37.85	63.6	1064
New York to San Francisco	23.47	39.42	1924



Switched 56 connections *can serve most applications that demand high-speed communications: videoconferencing, network interconnectivity, or mainframe links. Each end of the connection must have a CSU/DSU and perhaps a bridge or router.*

dramatically reducing throughput.

The 16550 UART with its 16-byte receive and transmit buffers solves this problem. With a 16-byte buffer, the CPU now has 16 times as long, or 2.77 milliseconds, between reads of the receive buffer. This affords sufficient time for the CPU to respond and service longer interrupts from drives or lumbering code. Even so, Windows—particularly disk caching under Windows—generates interrupts so long that even the 16-byte buffer of the 16550 may not be enough. To handle this, some companies have built communications boards with larger buffers.

There are a few ways to find out if your PC has buffered (16550-based) or non-buffered (8250- or 16450-based) asynchronous serial ports. The most direct way may be to just look under the hood. Alternatively, you can download one of the UART identification programs available on most BBSes. These programs tell you the quantity and type of serial ports in your PC. If your computer has a buffered asynchronous serial port, then you need only make sure that your software knows how to take advantage of the buffer.

Once you believe you're ready, you can run a final verification test by transferring a few large files between PCs using a null-modem cable. Most communications programs give file transfer statistics showing retransmissions and average throughput. This data will tell you whether you're making the most of your 5760-cps potential.

In some extreme cases, you may find that even with a buffered UART and appropriate software, there are still some block retransmissions, caused by an overwritten input buffer while the PC services a long interrupt. Possible remedies for this include using a serial port with an even longer buffer (make sure the software can take advantage of it—there is no de facto standard for such a card) or pacing the transmitter slightly (i.e., increasing the intercharacter timing).

A more expensive alternative ($600 versus $60) to standard 57.6-Kbps asynchronous serial ports comes in the form of synchronous 56-Kbps serial communications boards with large built-in buffers and separate processors. These cards off-load the communications task from your main CPU and typically provide an error-corrected HDLC data link. However, they are not that commonly used today, they have proprietary interfaces, and they usually must be interfaced to custom software. You would probably use this arrangement only if you were connecting to a mainframe in a corporate synchronous network.

Large corporations often have T1 (multiplexed digital) lines. This offers the possibility of further Switched 56 savings through bypassing the local telephone company. A heavy calling volume can be a factor in justifying this kind of arrangement. To determine whether your calling volume is high enough, calculate the crossover point in number of minutes by dividing the allocated monthly cost of the dedicated access channel by 5 cents, which is the per-minute rate the telephone company charges for providing access to long-distance carriers.

Hooking Up

There are two ways to make a local digital connection to a central office. The more common is known as *4-wire*. This uses independent pairs of wires for data transmission and reception. A slightly less common arrangement is known as *2-wire*, or *Datapath*. This uses one pair of wires and time-compression multiplexing to provide both directions of transmission on a single pair of wires. In time-compression multiplexing, the use of the single pair of wires is reversed every millisecond. For the first millisecond data is outgoing, and for the second millisecond the data is incoming. Which arrangement you use depends on which type your local telephone company offers.

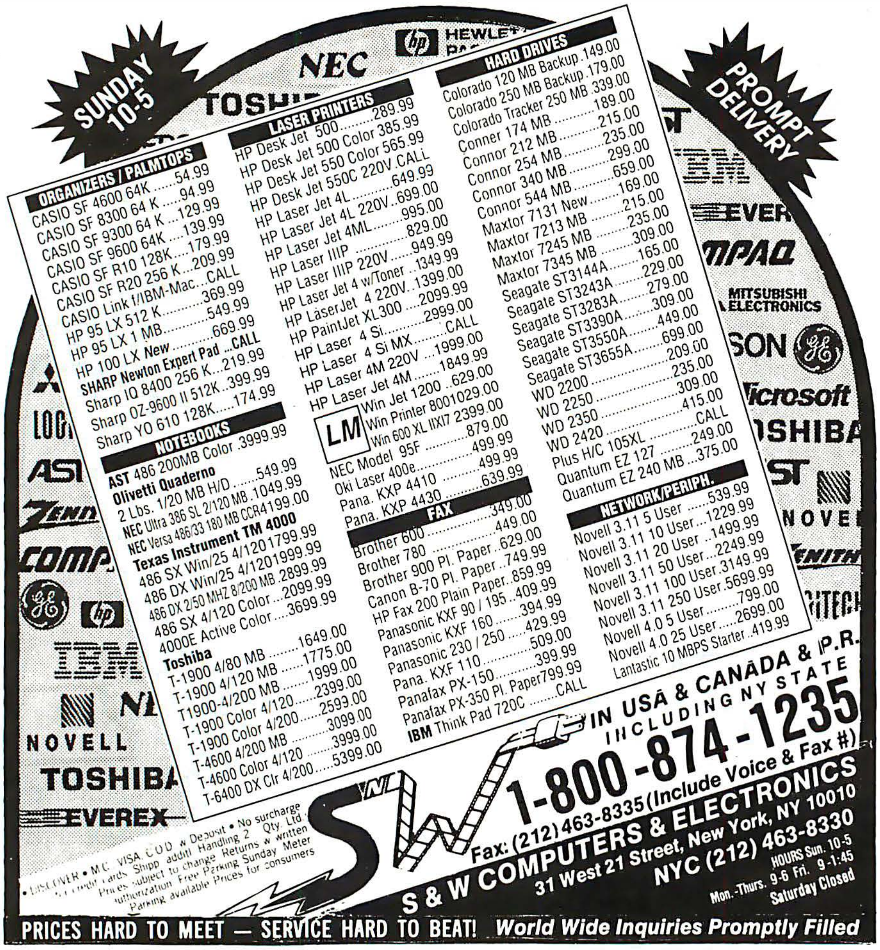
Each telephone company calls its Switched 56 service by a different name, and a local telephone business office may not be familiar with digital services. This is why you should request a guide to services in your area. You can download such a listing of services, tariffs, and customer contacts from various BBSes and from BIX. [Editor's note: *For details on connecting to BIX, see page 5*.]

Installation costs vary widely: In California, Pacific Bell waives the installation charge if you keep a line for two years; in New England, the cost averages around $300. Usage charges are basically the same as for regular telephone lines. Monthly recurring charges are comparable to POTS business-line charges, ranging from $10 to $90 per month.

ISDN-Compatible

ISDN is essentially two 56-Kbps (sometimes 64-Kbps) data channels carried over a 2-wire technology called 2B1Q, which is incompatible with the 2-wire Datapath technology mentioned earlier. On top of this is a separate 16-Kbps channel for call control or X.25 packet data.

Switched 56 is compatible with ISDN BRI (Basic Rate Interface). This compatibility is important for companies with global networks, since Switched 56 is not



Feature

available in Europe and elsewhere but ISDN probably is. Where the ISDN service is not available, Switched 56 can step up to build large regional or national networks.

Among the problems that have delayed ISDN's deployment has been the cost of converting central office and interoffice facilities. Upgrading even existing digital switches to ISDN can cost from $500,000 to $1 million per switch. With this cost structure, some telephone companies have been reluctant to convert a central office without a guarantee of hundreds of subscribers on the day the conversion is complete. As a result, until recently, most telephone companies offered only a Centrex ISDN tariff. (Centrex is a multiline service where a portion of a central office switch provides PBX-like functionality to a business.) The majority of telephone companies still don't have single-line ISDN BRI tariffs in place, although most are planning for them by the end of 1993.

> **Upgrading digital switches to ISDN can cost $500,000 to $1 million per switch.**

There is no existing standard for asynchronous 57.6-Kbps communication between Switched 56 CSU/DSUs, or between Switched 56 CSU/DSUs and ISDN BRI equipment. Some CSU/DSU manufacturers base their 57.6-Kbps asynchronous format on a commonly available Motorola DSI (Data Set Interface) that changes the asynchronous 57.6 Kbps to and from a synchronous 56-Kbps format with HDLC-like frames. This HDLC is available to the industry as a protocol developed by the ISO.

Even as ISDN deployment continues, there will be places where there is no economic justification for upgrading the central office. In these places, Switched 56 will remain the only way to provide high-speed digital bandwidth on demand. ■

Daniel M. Joffe is the director of network access equipment at Integrated Network Corp. (Bridgewater, NJ). You can reach him on BIX c/o "editors."

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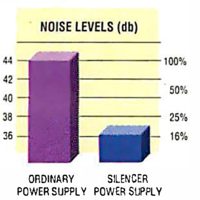
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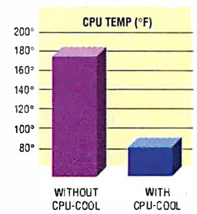
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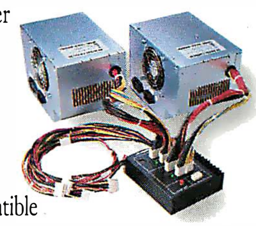


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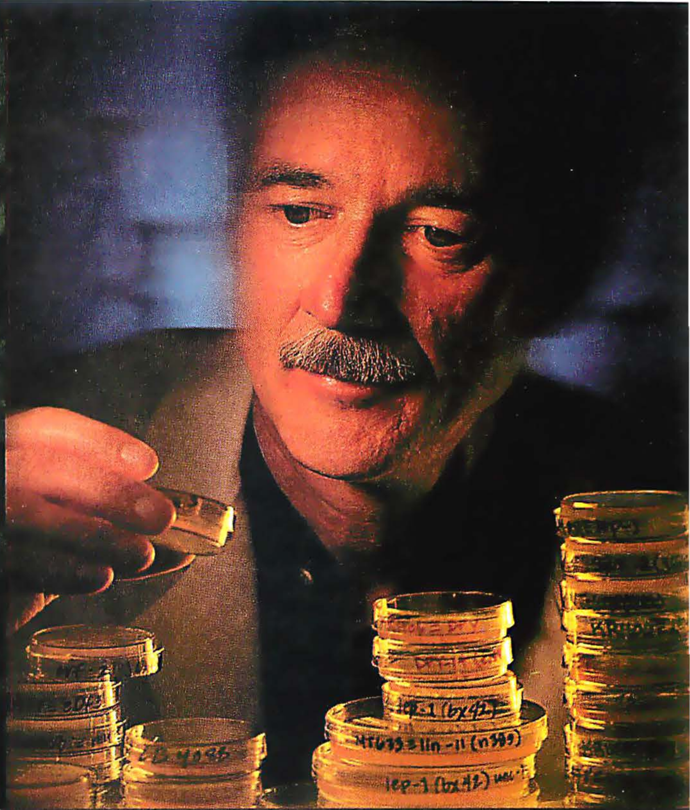
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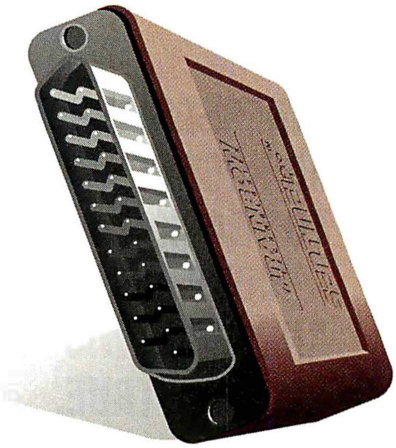
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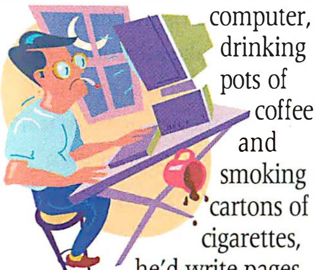
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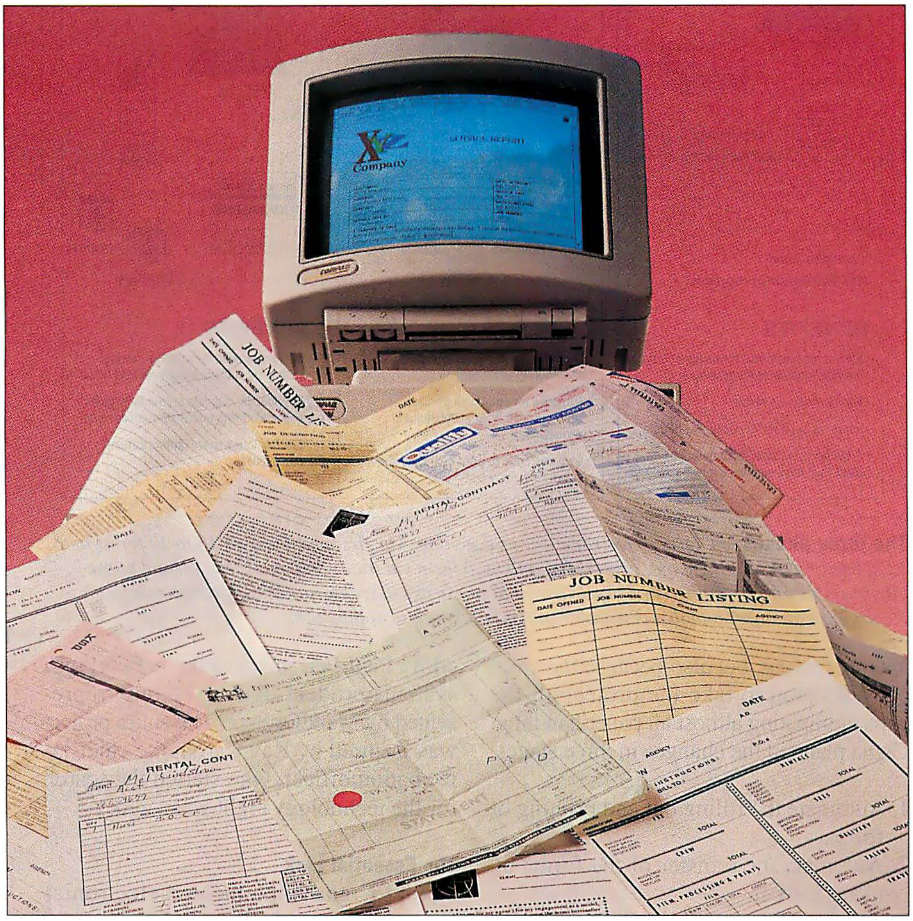
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In Good Electronic Form

BEN SMITH AND
HOWARD EGLOWSTEIN



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A large insurance company and a small manufacturing firm save time and money with electronic forms

Truth be told, there is no such thing as the paperless office. Today's offices wouldn't function without forms—contracts, supply requisitions, purchase orders. And it's not enough to fill out the forms; somebody has to process them. Even small companies often have employees whose only job is to handle insurance and tax forms.

For Cigna Insurance, the move from paper to electronic forms not only sped up the processing but also saved millions of dollars in printing costs, storage, shipping and postage, and waste removal. And it paved the way for even greater productive use of Cigna's huge network. For a relatively small company like Trace Technologies (a San Jose, CA, maker of magnetic-media duplicating equipment), the motivation was compliance with ISO9000 (a specification for business organizations), but again the immediate returns have been increased productivity.

Moving Mountains

Cigna Insurance is an international company whose services have depended solely on moving information, but a major operating expense has been the mountains of paper that hold that information. By reducing the amount of paper without reducing the information flow, the company stands to save a considerable amount.

Cigna's corporate headquarters employs over 5000 workers in a Philadelphia skyscraper. But the company has over 500 offices spread over several continents, with a total of more than 45,000 employees.

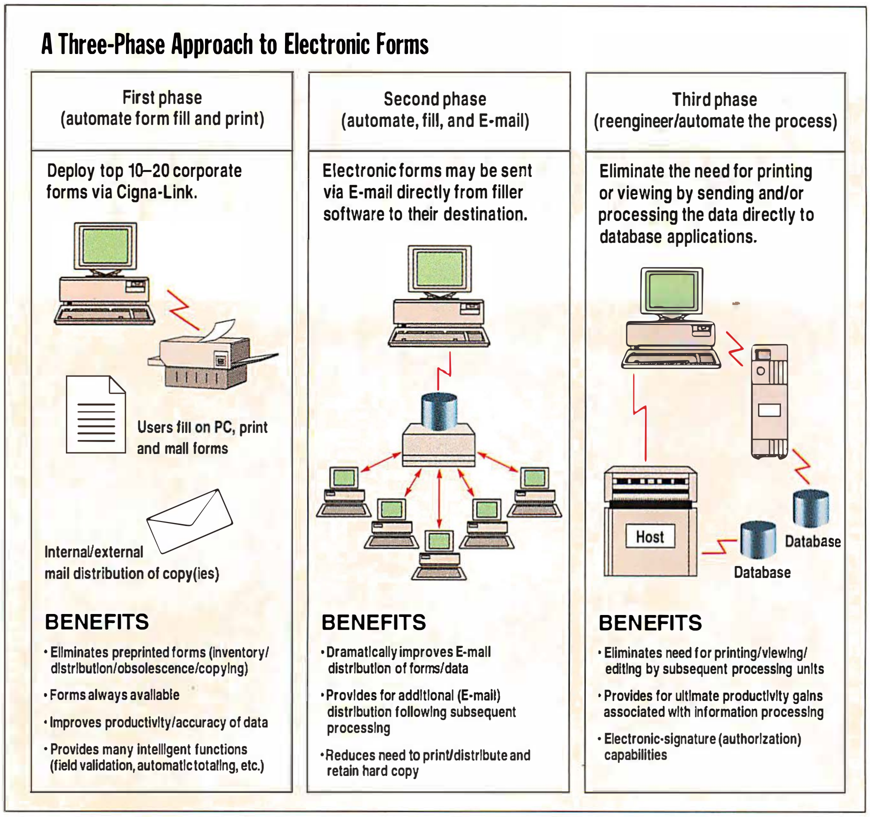
That's the scale of the company; the scale of the paperwork is even greater. Internally, Cigna uses more than 300 different forms. Externally, with its agents and corporate clients, it distributes over 35,000 different forms. This represents tens of millions of sheets of paper a year: warehouses of blank forms and of forms that have been filled out and filed.

When any of these forms become obsolete, all the unused copies are discarded and new forms are printed and distributed. This may be good business for the paper industry and printing companies, but it costs Cigna millions of dollars a year. Just moving the paper forms to an electronic format would prevent tremendous waste and reduce the expenses of warehousing and distributing the paper forms.

But blank forms are only part of the expense. If Cigna could also reduce the filled-out forms to electronic format, it would realize tremendous savings from not having to file and archive the paper. As a bonus, the company would retain the information in the format needed to process it as computer data; normally, a data-processing center rekeys the data from stacks of paper forms.

Big Changes in Three Stages

The project to automate forms at Cigna is an important case to study, not only because of the scale of the company's paperwork



The three phases *of Cigna's electronic-forms adoption. The first phase moves 10 to 20 forms onto PCs, where users fill them out, print them, and mail them via traditional mail. The second phase incorporates forms routing via E-mail. The final phase ties in a data-processing component with electronic signatures and direct transfer of data to database applications.*

and processing, but also because the company decided to take the project all the way, eliminating almost all paper handling. Cigna planned the changes in three stages:

1. Automate the filling out and printing of forms.
2. Automate the transfer of the forms by using E-mail.
3. Tie the forms processing directly into data processing.

Cigna had to implement each stage carefully so that the new process would not interrupt the operations that were already in place. First, the company selected a subset of 10 corporate (in-house) forms to be "electronified." Of that set, one form, the internal purchase-request form, was chosen as the test of the technology.

This form had all the complexities inherent in the other hundreds of forms. In particular, its approval path required both electronic-signature verification and electronic-forms routing. This one pilot project takes the original request from the Cigna employee all the way through the approval process, even to the point of issuing the order to the vendor.

Two groups brought these plans to fruition: the forms management group, headed by Paul Ferrand, and the networking/systems product-delivery group, represented by Mark Orthner. The entire project was inspired by Ray Caron, the chief information officer, who started the search for the technology eight years ago.

The Essential Link

Before Cigna implemented electronic-forms routing, it had to establish a solid infrastructure on which to build. Mark Orthner and others of Cigna's systems division (now more than 4000 strong) developed Cigna-Link, a huge enterprise network and E-mail system.

Cigna-Link consists of more than 500 separate IBM Token Ring networks loaded with 386 (or better) PCs. Each office maintains a Token Ring network. For instance, the Philadelphia office ties its 5000 PCs together, along with 76 file servers, on a 16-Mbps Token Ring network. The Token Ring networks talk to IBM mainframes connected with an IBM SNA (Systems Network Architecture) network over T1- and T3-grade leased phone lines. The mainframes had been the data-processing core of Cigna's operations back when IBM 3270 terminals sat on everyone's desk.

Cigna-Link gives everyone in the organization a smooth, seamless link to the system's E-mail and file storage. Cigna-Link workstations are also highly standardized. We saw a variety of hardware vendors represented in the Philadelphia office, but the software is essentially the same on all 25,000 machines: Microsoft Mail 3, WordPerfect 5.x, assorted compatible versions of Lotus 1-2-3, and IBM LAN Server client software. Some machines run Microsoft Windows; some are still running DOS.

Orthner is quick to point out that Cigna-Link's most significant attribute is not its topology, but the fact that there is only one LAN network operating system (LAN Server 3 from IBM) and one E-mail system (Microsoft Mail 3) throughout the entire enterprise. Cigna's current electronic-forms distribution system would be impossible without this standardized, mature infrastructure. The painful process of bringing an entire corporation under a single set of standards was somewhat alleviated because the standards were in place before a PC-LAN anarchy developed. One of Orthner's suggestions (see "Tips from the Experts" on page 76) is that you put the network in place, get your E-mail running reliably, and make sure everything is working before you attempt an electronic-forms solution.

Eight Years of Electronic Forms

Eight years ago, Cigna adopted a mainframe-based forms design product. With it, sales agents could customize the necessary forms to conform to their clients' requirements. The forms design program applied a set of preprogrammed rules to the profile of the company (i.e., its size, the kind of business, and so on) and created a contract form with all the right clauses and paragraphs for the customer. In addition, it automatically generated additional forms or contracts that might be applicable.

Cigna's next step was to adopt form-filling/data-entry software so that sales agents could fill in forms at a computer. To help make electronic forms more acceptable, the electronic form looked, on-screen, just like the paper version. However, the data-entry fields incorporated some error checking. The completed form could be printed out or even sent directly to Cigna's database system. Cigna started working with form-filling products in 1987, but these early versions of forms software did not have all the capabilities Cigna needed.

In 1991, Cigna began an internal pilot program with 120 forms. This system produces health-care paperwork for large corporate customers. With this project, the electronic forms and design team learned that the electronic form does not need to



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look identical to the paper form. It's nice to have the screen presentation look like the paper form it replaces, but it's not always necessary, and sometimes it's not desirable. Instead of letting the forms software dictate the form's appearance or simply mimicking the paper form onto the screen, the forms automation group goes through a *process engineering* step: When the group puts a form together, it determines how a department plans to use the form and analyzes the current paper form's layout.

One example of a reengineered form is a purchase requisition. On a paper form, you might have a section where you could enter a long list of items. At the top of the list are the headings that describe the different columns. But you can't fit as many lines of text on a 24-line computer screen as you can on paper, so repeating the column headings periodically throughout the section makes it easier for end users to remember where the data goes. For a special comment section, where the paper form might have room for several lines of text, the electronic version could start out with one line and expand as needed. Cigna considers the user interface critical and puts a great deal of effort into its design.

Questions about Routing

The next obvious step was to implement electronic-forms routing—a form and its data moving through the network via E-mail. A basic premise of electronic-forms routing is that paperwork doesn't necessarily flow in a straight line; depending on conditions, it may be rerouted or even returned to a previous status for further processing. The form must somehow maintain routing and status information. Either the form can carry this information with it, or the information can be maintained in an external database.

Other concerns center around security: Who can see the form? Who can modify the form's contents? How do you ensure that only the authorized signer has signed the document?

There must, of course, already be an E-mail or other network service in place that spans the entire network and is supported by the forms-routing application. Fortunately, the Cigna-Link network with its Microsoft Mail already provided the infrastructure for the forms routing. The more sophisticated database-structured forms-routing packages were still in development. So Cigna looked at the E-mail-based systems. As it turned out, only JetForm provided what Cigna needed: forms design, forms filling, forms routing via Microsoft Mail, and a secure electronic-signatures database.

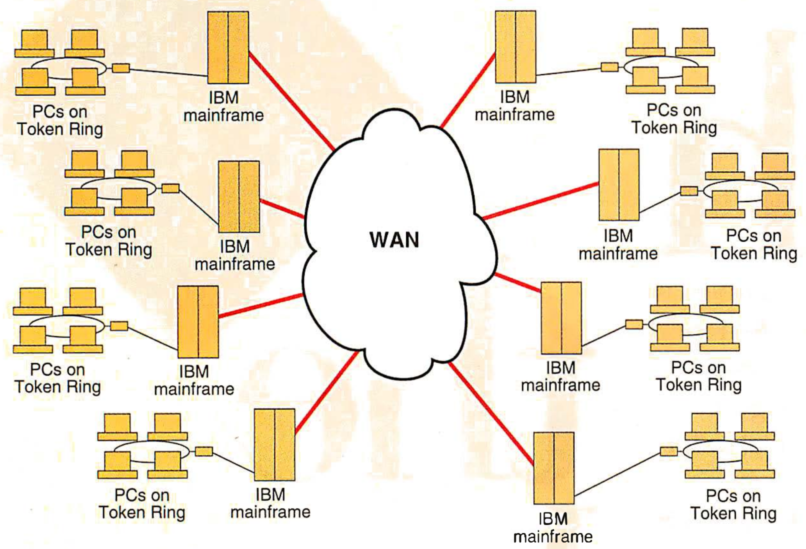
Cigna's Solution—JetForm

JetForm's solution consists of three basic parts: JetForm-Design, a Windows product that lets you design the appearance and function of your electronic form; JetForm-Filler (DOS and Windows), for entering data into the predesigned forms; and JetForm for E-Mail (DOS and Windows), to both enter data and transfer it through E-mail to another networked location. A fourth piece, JetForm-Server, runs under DOS or OS/2 to provide client-server forms handling.

Cigna's forms solution is conceptually simple:

- Use JetForm-Design to create both screen and paper versions of the form. Include the transfer information so that the form knows how to move from one place to the next.
- E-mail the finished form to each site so that it automatically installs itself onto

Anatomy of Cigna-Link



A simplistic view of Cigna-Link, *Cigna's WAN (wide-area network) infrastructure. Each office runs PCs over a Token Ring network. The Token Rings talk to an IBM mainframe. The mainframes are connected with an IBM SNA network over T1- and T3-grade leased phone lines.*

each of the 25,000 machines.

- When a user fills out a form, make the data available for printing on a local printer or for sending off electronically. JetForm for E-Mail takes care of dispatching the data through the mail system.
- Obtain an approval/signature, if one is required.
- Route the form on to the next site.

Two of these steps present challenges worth mentioning. First, distributing the form to each of the workstations on a huge network requires a tight integration between your forms package and your mail system. You also have to make sure that you've tested out everything thoroughly: You wouldn't want to distribute 25,000 copies of a defective form. Second, approvals/signatures, simple on a small network, can be a significant problem on a large network.

The typical way of handling electronic signatures on a LAN-based forms system is to use public-key encryption (see "Digital Signatures" on page 309). When a form requires your signature, you move the cursor to the signature field. The forms software presents a list of authorized people, and you select your name from the list. After you enter your password correctly, the data on the form is secured and encrypted. From then on, anyone reading the form can decrypt it, but not change it. Further approvals work the same way.

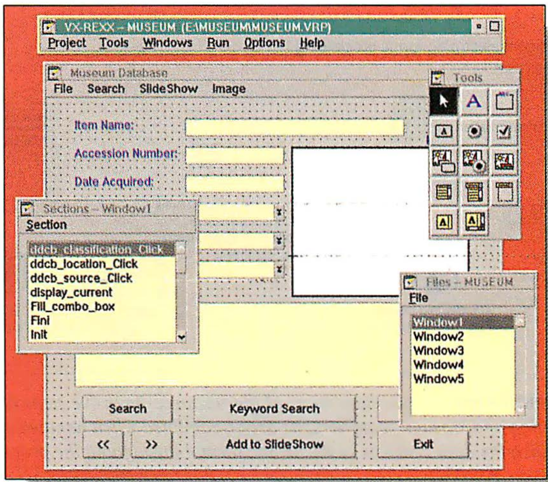
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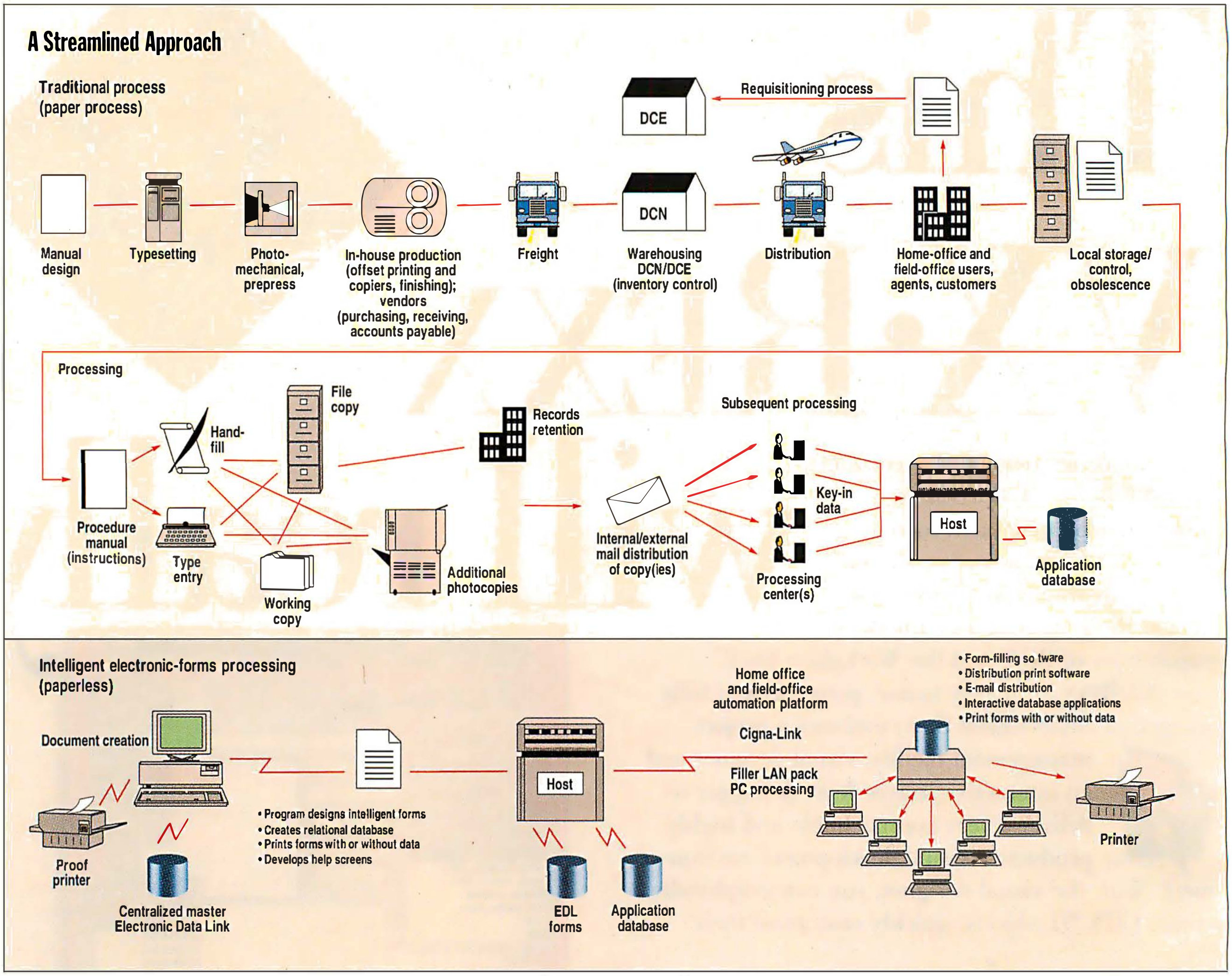
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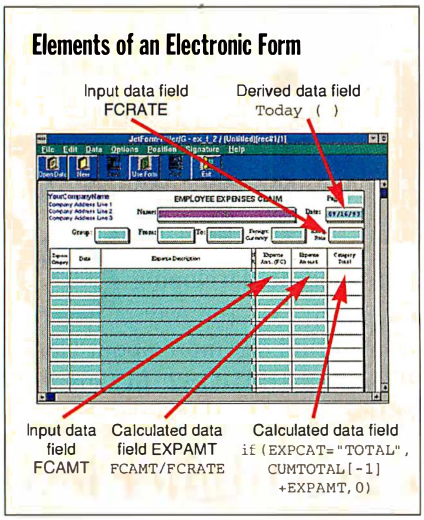
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Electronic forms *can alleviate many of the resource-intensive steps of forms processing. Traditional typesetting and printing steps are unnecessary. Distribution and storage requirements are streamlined when handled electronically. And processing centers do not need to rekey data from paper-based forms, since the data remains in electronic format throughout the process.*



An electronic form *can prevent errors by validating entries, and it can save time by filling in parts of the form automatically. Along with these embedded rules, the form can carry routing and tracking information.*

The only disappointment with JetForm was that the signature database didn't scale up to Cigna's requirements—a distributed database with 25,000 records. What JetForm evolved for Cigna was an ability to use the Microsoft Mail signature system in place of JetForm's. You have to log onto the server and your mail system anyway, and the server has to have your password handy. When you need to sign a form, JetForm asks you for your network ID and password; if you enter them correctly, the form is secured. This is not as safe as the public-key method, but it doesn't require anything special from the network.

In 1½ years of work with JetForm, Cigna has moved 1800 forms over to electronic format. Of that set, 30 forms have progressed all the way to electronic routing. Cigna is just beginning the process of interfacing the routed forms directly to its databases. Currently, the company is only partially through stage two of the three-stage program.

Pains and Gains

Despite the tremendous work that Cigna has done and the accomplishments the company has achieved, Paul Ferrand says the project is still in the "show me" stage. Cigna is committed to totally automating all the appropriate forms, but offices within Cigna still need to be convinced that this is all worthwhile.

The forms automation group has invested a tremendous amount of time in "dog-and-pony acts" to demonstrate the usefulness of electronic-forms routing. This investment in time has really helped smooth the way for change.

Cigna estimates that it can save 80 percent of the cost of handling internal forms with the system that is in place. That's a pretty significant piece of change. While Cigna wouldn't put an exact dollar figure

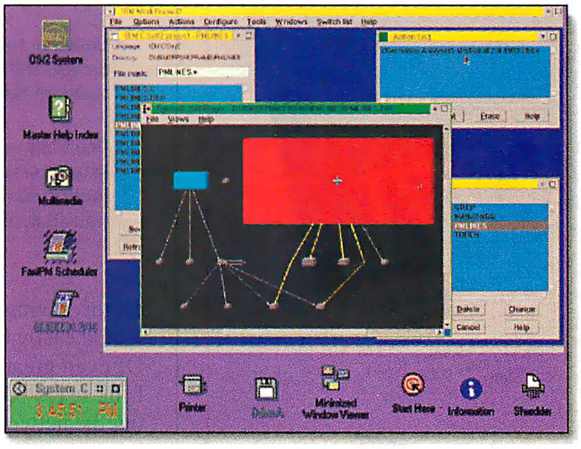
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Tips from the Experts

If you're considering an electronic-forms solution, Cigna and JetForm have several suggestions:

- **Make sure your network and E-mail systems are fully implemented and stable before you begin looking at forms software.**
- **Don't be swayed by a large bundle of prepackaged forms. It's not likely that you'll want to use any of them directly; you'll want to design your own.**
- **Instead of simply transferring your paper forms to the screen, rethink the form. Is it really necessary? Do you need all that data? Don't ask your users to do any more work than necessary.**
- **If your forms package lets you use the same data in both screen and printed form, the screen form doesn't have to look exactly like the printed version. The screen may need a different format to use space efficiently.**
- **Once you select a product, switching to another will be difficult. There are no standard electronic-forms formats.**
- **Don't buy vaporware. If a vendor doesn't have a component you need for your forms system, ask yourself if you can live without it, or look elsewhere.**

on the savings, any reasonable estimate would easily be in the millions of dollars. Of even greater value to Cigna is CignaLink users' change of attitude about using the network and E-mail system to automate other tasks. As Ferrand puts it: "We are just touching the surface of the capabilities of these systems."

On a Smaller Scale

It isn't just the huge paper-based operations like Cigna that have benefited from electronic-forms routing. Trace Technologies has started moving its operations over to electronic forms.

Trace is a leading manufacturer of digital-media copy equipment for the computer industry. Its worldwide operation employs only 275 people (tiny compared to Cigna). Its network consists of two HP 3000 database servers and many MS-DOS/Windows PCs mixed with just a few Macintoshes. It is a multiprotocol 10Base-T Ethernet network, but with a single E-mail system. Because of the scale of operations at Trace, only one person, Felix Camerino, has the responsibility for working out the move to electronic forms.

Trace is working on gaining ISO9000 certification. ISO9000 is an international standard for total quality management. One of its elements is office automation with electronic-forms routing (called *automate with validation*). Therefore, implementing electronic forms has a dollar value independent of the operation's expense savings. And the expense savings are considerable: Time-card automation will bring savings of $30,000 per year, and all five forms of the pilot project should save about $250,000 per year.

Camerino considered other LAN-/E-mail-based forms-automation paths, but he, too, found that JetForm fit the needs better than any other existing package. One major consideration was that it worked well with cc:Mail.

Camerino created and evaluated a prototype system for payroll time sheets. The evaluation period lasted six months and required one JetForm-Designer license and 10 JetForm-Filler licenses—an initial investment of $15,000 for licenses. The original time-sheet electronic-form design took him roughly 80 hours, even though the form had nearly 600 data fields, each with an associate attribute or formula.

After the pilot program started, Trace completely changed its processing and policies for time cards, so Camerino has made a second version of the electronic form. The second version will be distributed to users along with the JetForm-Filler licenses.

Now and the Future

In the next few years, we will see sophisticated forms-routing products that will reach beyond even what JetForm offers now. These emerging products will manage and track all aspects of a company's work flow. Forms routing will be only an element of this broader ambition.

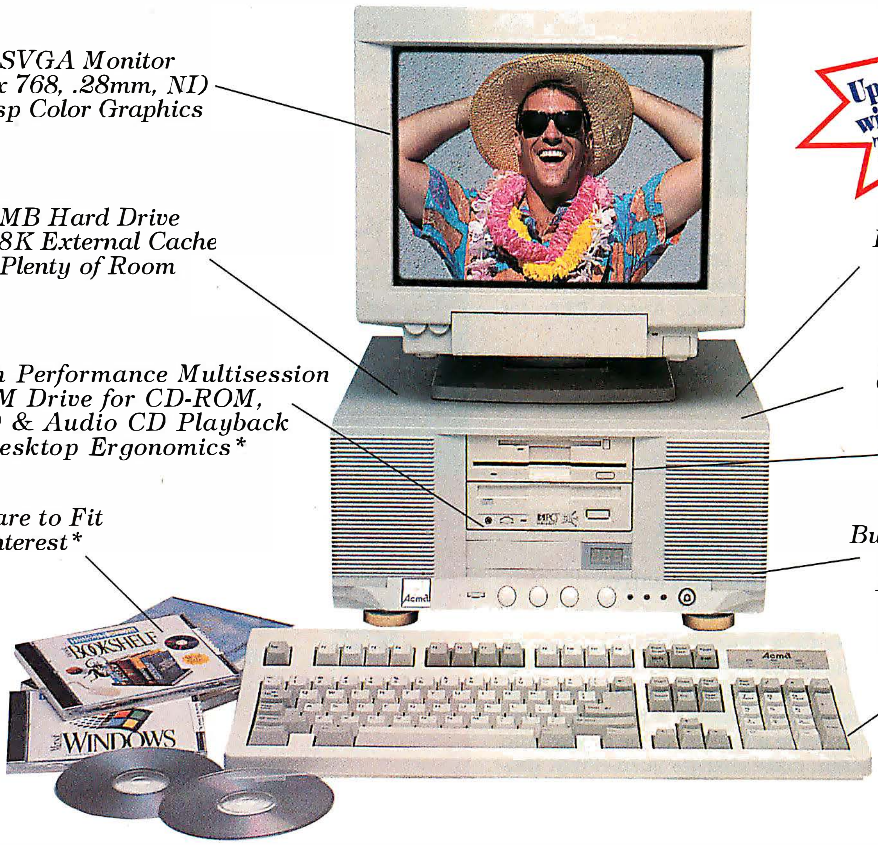
But for now, the electronic-forms software is sufficient for sophisticated operations. An electronic routing system can reduce expenses and increase productivity for companies with only a few hundred employees on up to organizations tens of thousands strong. ■

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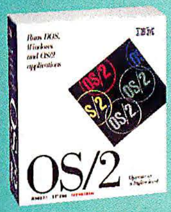
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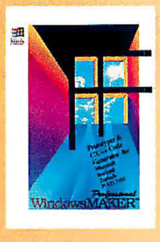


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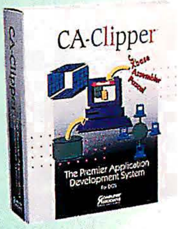
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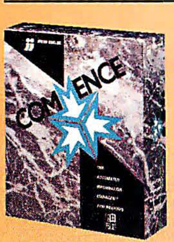
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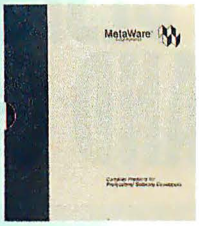
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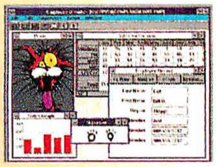
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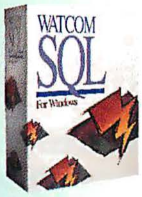
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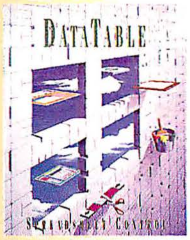
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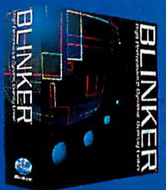
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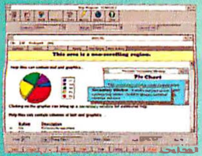
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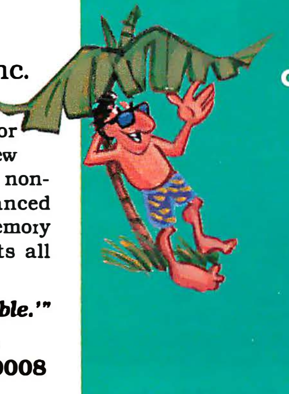


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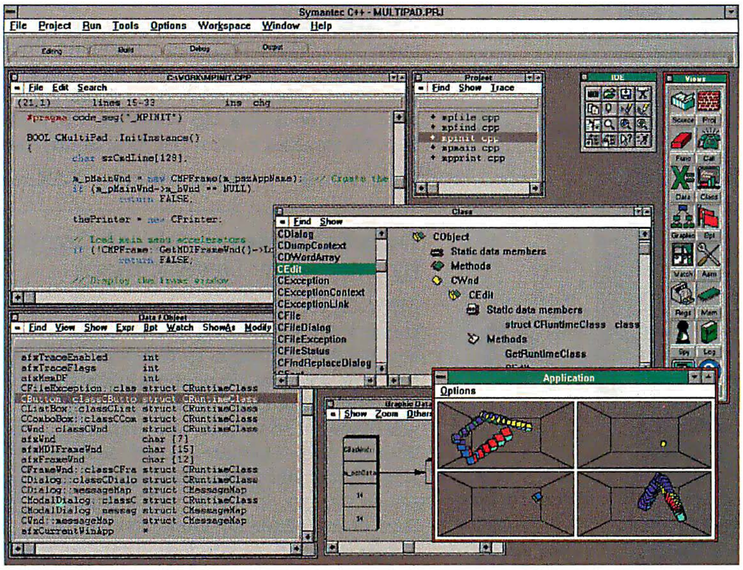
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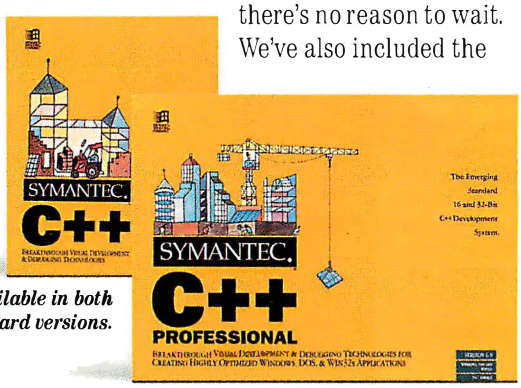
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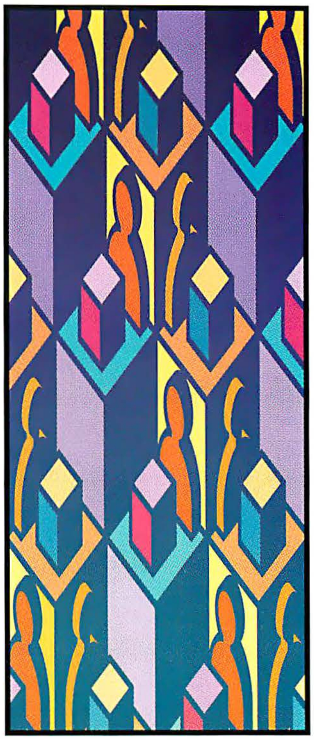
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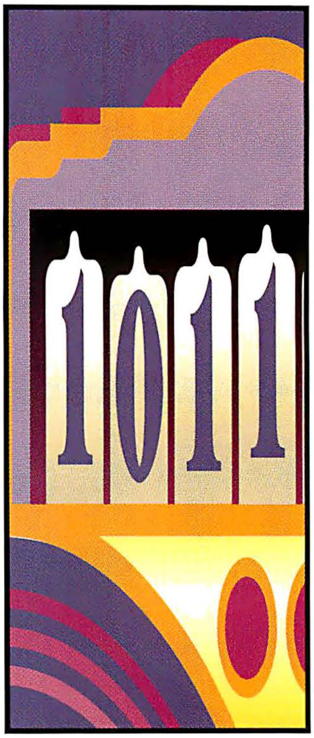
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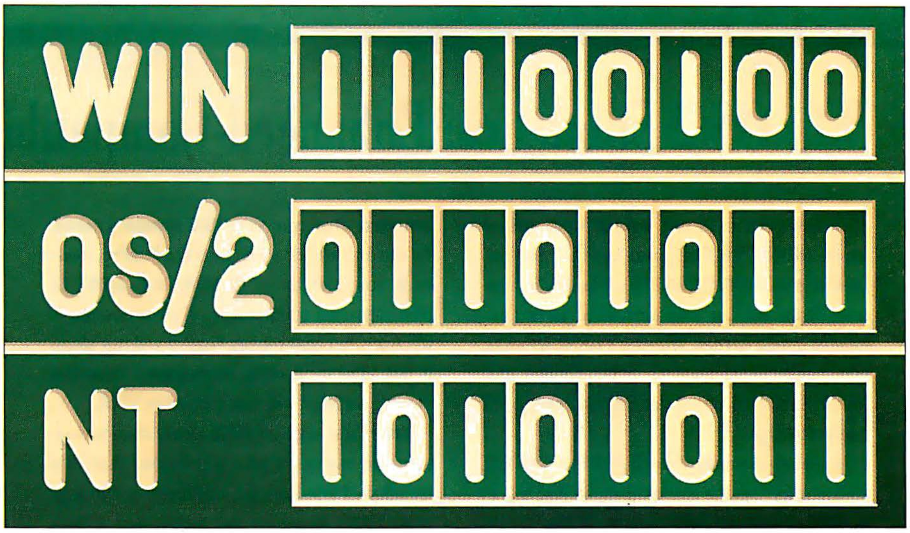
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COVER STORY

Is There a Better Windows 3.1 Than Windows 3.1?

Windows, OS/2, and NT offer distinct benefits and disadvantages. One of them excels at running standard Windows applications. But the best choice depends on your requirements.

JON UDELL



DANIEL PELAVIN © 1993

Let's get right to the point: The answer is no. I ran the BYTE Windows application benchmarks and the BYTE Windows low-level benchmarks on five fast Intel systems under Windows 3.1, OS/2 2.1, and Windows NT 3.1 (and on two RISC systems under NT alone). For applications, the hands-down winner was Windows 3.1.

That's a result that should surprise no one. Running 16-bit Windows software is not the primary mission of either OS/2 or NT. These are robust operating systems built to run 32-bit Presentation Manager and Win32 applications, respectively. Of course, if you adopt one of these systems to run mission-critical line-of-business applications, you won't want to forgo standard productivity applications like the ones in our application suite—Excel, Ami Pro, and Superbase. And since PM and Win32 versions of these aren't yet available (Ami Pro for OS/2 was imminent but missed our deadline), that means you'll be leaning on the Win16 support built into OS/2 and NT.

The good news is that your Win16 applications will run on the Win16 subsystems of both OS/2 and NT. The bad news is that they will run more slowly there than under straight Windows 3.1.

There are, of course, a number of ways to qualify that statement. For starters, note that Windows 3.1 posts the best marks when running in standard mode, not 386 enhanced mode. Windows 3.1 narrowed, but clearly did not eliminate, the performance gap that made many Windows 3.0 users prefer standard mode. Despite that gap, however, 3.1 users need enhanced mode to multitask DOS, to run virtual device drivers such as the 32-bit FastDisk driver and the Windows for Workgroups network components, and to run 32-bit Windows-extended applications.

If you don't rely on any of these features, you might as well run Windows 3.1 in standard mode. On three of the four systems for which the comparison was possible, the overall applications index for standard mode was 12 percent to 15 percent better than for enhanced mode. If you're like most Windows users, however, you do rely on enhanced-mode features. Note that while both OS/2 and NT lag behind Windows 3.1 in Win16 application performance, they lag enhanced mode by less than they lag standard mode.

Tales of the Triple Boot

Despite horror stories you may have heard, Windows, OS/2, and NT can coexist peacefully on the same hard disk. Once you install all three, switching among them is straightforward. However, there is no master boot utility that can control the whole show. OS/2 provides two mechanisms: a simple dual-boot utility and the Boot Manager, which can switch between an operating system that boots from drive C and an arbitrary set of operating systems that can boot from other partitions. NT offers only the equivalent of OS/2's dual-boot utility.

Ideally, you would let Boot Manager (or an equivalent)

handle everything. Launching from its active 1-MB partition, it would present three choices: DOS/Windows on primary partition C, OS/2 on a logical partition, and NT on another logical partition. Unfortunately, NT, like DOS, wants to boot from partition C. That dictates a two-tiered boot strategy. You first make a C partition on each system—reserving space for a D partition and Boot Manager—and install DOS 5.0 and Windows 3.1 on C. You can then install OS/2 and NT in any order.

If OS/2 goes on first, say on drive D, add drive C to the Boot Manager menu as usual. Then, while booted to DOS from C, install NT. The only complication is that NT will make C the active partition. To recover Boot Manager and gain triple-boot capability, use FDISK or NT's Disk Manager to set NT's partition active again. (NT informs you that you need to reactivate Boot Manager if you want to use it.)

Alternatively, you can install NT on top of DOS/Windows and then add Boot Manager and OS/2 into the reserved space on the disk. Either way, use Boot Manager to control a primary choice between DOS and NT on drive C and OS/2 on drive D. When you choose C, you'll land in NT's dual boot, which controls your secondary choice between DOS and NT.

On one system, an IBM PS/2 Model 90 XP 486, I forgot to leave room for separate OS/2 and Boot Manager partitions. Stuck with OS/2's dual boot, I used the `boot` command to switch to DOS. Next, I installed NT with its dual booter. The system was then switchable between DOS and NT.

If OS/2's dual booter switched to OS/2 and then back to DOS, would it restore NT's dual booter faithfully? Half expecting to find that I had sawed off the limb I was sitting on, I tried the experiment ... and it worked just fine.

The moral is that, while triple-booting DOS, OS/2, and NT may not be an exercise for the casual user, you shouldn't run into any trouble if you're inclined to test these operating systems head to head—assuming, of course, that your disk can hold them all. Don't forget that NT's hefty swap file (28 MB on a 16-MB Intel system) makes it a voracious disk hog.

Into the Starting Gate

While OS/2 won points with me for its wonderfully flexible Boot Manager, NT's

Win-OS/2 Subtleties: Enhanced-Compatibility Mode and DDE

Windows 3.1 uses one kernel for standard mode (KRNL286.EXE) and another for enhanced mode (KRNL386.EXE). Win-OS/2, however, uses only an IBM derivative of the enhanced-mode kernel. Win-OS/2 KRNL386.EXE can, confusingly, operate in two modes that IBM calls standard (the default) and enhanced compatibility.

In standard mode, Win-OS/2 KRNL386.EXE always runs with the standard-mode flag set. In enhanced-compatibility mode, it loads with the enhanced-mode flag set, switches temporarily to standard mode to suppress the loading of virtual device drivers (since OS/2 doesn't support virtual device drivers), and then switches back to enhanced mode.

Why bother with this rigmarole? Applications like Mathematica, FoxPro, and Interleaf Publisher use Windows extenders to gain access to linear extended memory, and the extenders depend on enhanced mode. Why, then, isn't enhanced-compatibility mode the default? "I lost that battle," says Win-OS/2 architect Ayo Anise.

Probably IBM should have listened to Anise, because users of 32-bit Windows 3.1 software under Win-OS/2 can run into some strange problems, the causes of which are not immediately apparent. Ordinarily, when you run multiple Windows 3.1 applications under Win-OS/2, they share a single VDM (virtual DOS machine) that supports either a full-screen or seamless display in Win-OS/2 standard mode. To run an extended program like FoxPro, however, you have to set its WIN_RUN_MODE to 386 enhanced compatibility. It's not obvious to the user, but that means FoxPro will run alone in one VDM while other applications using the default settings will share another VDM.

You might argue, as IBM loudly does to anyone and everyone who will listen, that this isolation of Windows 3.1 applications into separate VDMs means greater robustness: A Windows spasm in one VDM won't affect Windows programs running in another. That's true, but the multi-VDM scenario causes problems for DDE. In the single-VDM case, applications share common address space; to perform a DDE data transfer, they need only exchange a handle. In the multi-VDM case (or in the case of Windows-to-Presentation Manager DDE), DDE messages and transaction data must move from one address space to another. IBM solved this problem by building a mechanism to relay DDE traffic across process boundaries. Unfortunately, it doesn't work as well or as reliably as it should.

To test DDE under Win-OS/2, I modified the DDEML (DDE management library) samples provided in the Windows SDK (Software Development Kit) to time a 1-MB data transfer between a DDE server and a DDE client. Under Windows 3.1 and single-VDM Win-OS/2, the transfer works reliably and (since there's no memory-to-memory copying) in a negligible amount of time. Under multi-VDM Win-OS/2, though, I ran into the same set of problems on several test systems. First, I had to tweak the transaction time-outs to make the transfer work. Second, transactions took an order of magnitude longer than they did under Windows 3.1 and single-VDM OS/2. Third and most troubling, the connection invariably broke after one successful transfer, and no further DDE transactions were possible without restarting both client and server.

IBM has gone to great lengths to portray multi-VDM Win-OS/2 as a robust alternative to the DOS multitasking of Windows 3.1. In general, it is. But—despite IBM's insistence to the contrary—you pay a price for that "crash protection." DDE across VDMs (or between Win-OS/2 and PM) is wobbly. OLE, which rides the DDE transport, also suffers.

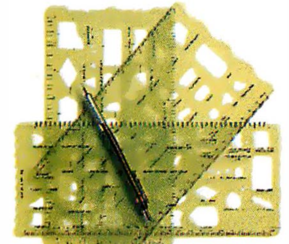
If you use 32-bit Windows software under Win-OS/2 and also rely on DDE, you should probably use enhanced-compatibility mode for all your 16- and 32-bit Windows applications. That way they'll share a common VDM, and you'll avoid DDE hassles.

What about NT? The Win32 subsystem handles DDE calls from both Win16 and Win32 applications evenhandedly. 16-bit DDE and OLE clients interoperate smoothly with both 16- and 32-bit DDE and OLE servers, and vice versa.



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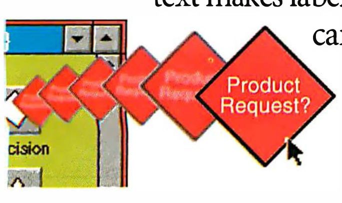
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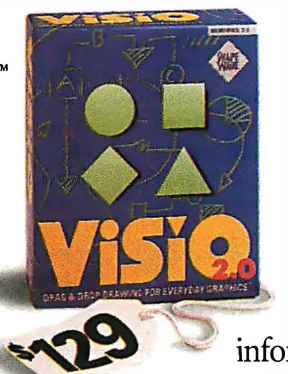
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BYTE WINDOWS APPLICATION AND LOW-LEVEL BENCHMARKS FOR WINDOWS, OS/2, AND NT

Machine: IBM PS/2 Model 90 XP 486
Processor: 486DX/33
Secondary cache: 256 KB
RAM: 16 MB
Drive controller: IBM SCSI-2
Video controller: XGA-2

	Windows Standard	Windows Enhanced	OS/2 Seamless	OS/2 Full-Screen	Windows NT
Ami Pro 2.0 (times in seconds)					
Load	1.33	1.30	1.80	1.80	1.53
Search and replace	5.63	5.77	5.67	5.67	5.97
Last page	3.50	3.47	3.57	3.60	3.73
Paragraph moves	10.93	10.43	11.40	13.80	16.33
Spelling check	2.10	2.20	2.57	2.43	6.07
Save file	1.97	1.80	2.50	2.37	2.70
Excel 3.0a (times in seconds)					
Open savage	11.00	11.00	11.33	11.00	12.33
Recalc savage	10.00	10.00	10.67	10.00	13.00
Goalseek	10.33	10.67	11.67	12.00	17.00
Superbase 4 1.30 (times in seconds)					
Insert	5.00	5.00	8.00	8.00	9.00
Index	4.00	4.00	4.00	4.00	3.00
Scroll	16.33	16.33	14.00	13.00	16.67
Remove	11.00	12.67	15.00	15.00	11.00
Sorted query	1.00	1.67	2.00	2.00	1.00
Word Processing index	0.98	1.00	0.69	0.67	0.62
Spreadsheet index	1.01	1.00	0.94	0.96	0.76
Database index	1.03	1.00	0.91	0.92	0.96
Overall index	1.01	1.00	0.84	0.85	0.78
WINDOWS LOW-LEVEL					
Primitive operations per second					
Pixels	8128.00	7910.00	3943.00	5872.00	2664.00
Lines	4641.00	4589.00	2272.00	4681.00	1335.00
Rectangles	3424.00	3435.00	2534.00	1670.00	831.00
Polygons	151.00	140.00	115.00	153.00	149.00
Ellipses	187.00	187.00	182.00	182.00	279.00
BitBlt	1436.00	1437.00	1711.00	1218.00	1373.00
Text out	674.00	569.00	552.00	407.00	459.00
Draw text	376.00	399.00	427.00	389.00	37.00
Local memory	13.00	13.00	13.00	13.00	12.60
Global memory	1.50	0.40	0.37	0.39	0.06
KBps					
Sequential I/O	373.00	342.00	662.00	668.00	839.00
Random I/O	1698.00	2221.00	2126.00	2147.00	5134.00
Graphics index	1.02	1.00	0.63	0.78	0.38
Memory index	1.08	1.00	1.00	1.00	0.94
File I/O index	0.89	1.00	1.09	1.10	2.33
Cumulative index	1.00	1.00	0.90	0.96	1.22

Machine: Everex Step 486DX2/50
Processor: 486DX2/50
Secondary cache: 256 KB
RAM: 16 MB
Drive controller: Adaptec 1742
Video controller: STB Horizon (Cirrus Logic 5426)

	Windows Standard	Windows Enhanced	OS/2 Seamless	OS/2 Full-Screen	Windows NT
Ami Pro 2.0 (times in seconds)					
Load	0.80	0.95	1.65	1.70	1.25
Search and replace	4.15	4.20	4.35	4.35	4.45
Last page	2.90	2.90	2.90	2.95	3.10
Paragraph moves	6.30	6.30	12.10	11.70	11.50
Spelling check	1.75	1.85	2.45	2.20	5.80
Save file	1.45	1.45	2.20	2.20	2.55
Excel 3.0a (times in seconds)					
Open savage	8.00	8.00	8.50	9.00	10.00
Recalc savage	7.00	7.00	8.00	7.50	10.00
Goalseek	8.00	6.00	13.50	13.50	11.50
Superbase 4 1.30 (times in seconds)					
Insert	4.00	5.00	8.00	8.00	9.00
Index	3.00	3.00	4.00	4.00	3.00
Scroll	8.00	8.50	16.00	17.00	18.50
Remove	9.50	10.00	13.50	13.50	10.00
Sorted query	1.00	1.00	1.50	1.50	1.00
Word Processing index	2.08	1.73	0.82	0.82	0.91
Spreadsheet index	1.38	1.38	1.09	1.09	1.01
Database index	1.35	1.27	0.90	0.89	0.96
Overall index	1.80	1.46	0.94	0.93	0.96
WINDOWS LOW-LEVEL					
Primitive operations per second					
Pixels	9242.00	8752.00	5810.00	7987.00	3076.00
Lines	3853.00	3774.00	2707.00	2924.00	2504.00
Rectangles	3860.00	3716.00	1295.50	1304.00	1460.00
Polygons	188.00	186.00	133.50	139.00	296.00
Ellipses	83.00	77.00	168.50	165.00	731.00
BitBlt	4137.00	4153.00	200.50	206.00	198.00
Text out	1456.50	1588.50	302.50	303.00	358.00
Draw text	426.50	512.50	372.00	361.00	371.00
Local memory	18.50	18.30	16.80	17.33	17.73
Global memory	1.62	0.54	0.47	0.41	0.04
KBps					
Sequential I/O	432.00	414.50	667.50	675.50	826.00
Random I/O	2521.00	2067.50	1400.00	1546.00	2765.00
Graphics index	1.25	1.22	0.59	0.72	0.48
Memory index	1.50	1.41	1.27	1.32	1.33
File I/O index	1.15	0.97	0.81	0.87	1.41
Cumulative index	1.30	1.20	0.89	0.97	1.07

Machine: ALR Flyer 32LCT 4DX2/66
Processor: 486DX2/66
Secondary cache: 256 KB
RAM: 8 MB
Drive controller: Ultrastor 15C
Video controller: VGA

	Windows Standard	Windows Enhanced	OS/2 Seamless	OS/2 Full-Screen
Ami Pro 2.0 (times in seconds)				
Load	0.60	0.77	1.67	1.03
Search and replace	3.13	3.37	3.37	3.33
Last page	2.13	2.10	2.20	2.17
Paragraph moves	5.73	5.53	6.43	6.03
Spelling check	1.40	1.37	2.03	1.50
Save file	1.23	1.10	2.63	2.10
Excel 3.0a (times in seconds)				
Open savage	6.00	6.33	7.00	6.00
Recalc savage	5.33	5.00	5.67	5.67
Goalseek	6.33	6.33	7.00	6.67
Superbase 4 1.30 (times in seconds)				
Insert	3.00	4.00	6.00	6.00
Index	2.00	2.00	3.00	3.00
Scroll	7.00	6.67	9.00	7.00
Remove	7.33	9.00	11.33	11.00
Sorted query	1.00	1.00	1.00	1.00
Word Processing index	3.33	2.59	1.06	1.86
Spreadsheet index	1.80	1.80	1.62	1.73
Database index	1.68	1.54	1.18	1.24
Overall index	2.27	1.98	1.29	1.61
WINDOWS LOW-LEVEL				
Primitive operations per second				
Pixels	23005.00	21116.00	9566.00	21230.00
Lines	2758.00	2576.00	2165.00	2570.00
Rectangles	1452.00	1444.00	1312.00	1425.00
Polygons	233.00	231.00	159.00	217.00
Ellipses	227.00	218.00	211.00	213.00
BitBlt	218.00	212.00	204.00	208.00
Text out	2175.00	2250.00	1910.00	2252.00
Draw text	945.00	742.00	813.00	844.00
Local memory	25.00	25.00	24.00	25.00
Global memory	0.93	0.69	0.50	0.56
KBps				
Sequential I/O	368.00	349.00	551.00	540.00
Random I/O	2670.00	2514.00	1204.00	1188.00
Graphics index	1.68	1.54	0.88	1.55
Memory index	1.94	1.92	1.83	1.91
File I/O index	1.18	1.12	0.68	0.67
Cumulative index	1.59	1.53	1.13	1.38

Insufficient RAM to run NT on this machine.

Note: Windows enhanced-mode results on the IBM PS/2 Model 90 serve as baseline for all application and low-level indexes.
Red = Best Blue = Worst

Machine	Gateway 2000 4DX2-66E	Machine	Unisys 5606e	Machine	SGI/Mips Magnum 75SC
Processor	486DX2/66	Processor	Pentium/60	Processor	Mips R4400/75-150
Secondary cache	256 KB	Secondary cache	256 KB	Secondary cache	1 MB
RAM	16 MB	RAM	40 MB	RAM	32 MB
Drive controller	Ultrastor 24F	Drive controller	Adaptec 7770	Drive controller	NCR 53C9X
Video controller	Diamond Speedstar 24x (WD 90C31A)	Video controller	ATI Mach 32	Video controller	SGI G346

WINDOWS STANDARD	WINDOWS ENHANCED	OS/2 SEAMLESS	OS/2 FULL-SCREEN	WINDOWS NT	WINDOWS ENHANCED	OS/2 SEAMLESS	OS/2 FULL-SCREEN	WINDOWS NT	WINDOWS NT
0.63	0.73	1.43	1.37	1.63	0.47	0.80	0.60	0.70	—
3.53	3.53	3.40	3.53	3.50	2.27	2.00	2.03	1.97	—
2.33	2.43	2.53	2.50	2.57	1.07	1.13	1.13	1.17	—
6.13	6.67	11.37	9.50	12.50	3.83	5.10	5.40	6.77	—
1.43	1.50	2.00	1.80	4.77	0.83	1.00	0.90	2.30	—
1.17	1.30	1.60	1.73	1.87	0.70	1.27	1.00	0.93	—
6.33	7.00	7.00	7.00	8.00	4.00	4.00	4.00	4.00	1.00
5.00	5.50	5.33	5.67	8.00	3.00	3.00	3.00	4.33	4.00
7.00	7.00	10.67	10.67	11.67	4.00	4.00	4.00	5.67	2.00
3.67	4.00	6.00	8.00	7.00	2.00	3.00	3.00	4.00	—
2.00	3.00	3.33	3.00	2.00	1.00	1.00	1.00	1.00	—
7.00	7.33	13.00	12.33	18.00	4.00	6.00	4.00	8.00	—
8.00	10.00	11.67	11.00	8.67	4.00	6.00	6.00	4.00	—
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	—
2.99	2.49	1.08	1.19	0.77	6.26	3.40	4.56	3.09	—
1.74	1.63	1.43	1.40	1.16	2.90	2.90	2.90	2.29	5.27
1.59	1.36	1.06	1.05	1.14	2.64	2.07	2.25	2.00	—
2.11	1.83	1.19	1.21	1.02	3.94	2.79	3.24	2.46	—
14787.00	11499.00	8276.00	9861.00	3305.00	18517.00	10640.00	20080.00	7070.00	6359.00
4892.00	4222.00	3791.00	4042.00	3369.00	21303.00	12060.00	22106.00	12715.00	3338.00
5426.00	4847.00	1864.00	1883.00	1715.00	12496.00	6520.00	8837.00	12741.00	1808.00
255.00	251.00	151.00	157.00	151.00	525.00	321.00	467.00	669.00	479.00
214.00	198.00	223.00	222.00	959.00	319.00	226.00	226.00	1468.00	815.00
2112.00	2084.00	273.00	284.00	241.00	4464.00	3957.00	4076.00	3048.00	1047.00
911.00	766.00	433.00	436.00	453.00	1947.00	1296.00	1378.00	605.00	336.00
546.00	466.00	484.00	460.00	461.00	1112.00	1083.00	1165.00	301.00	917.00
18.86	18.83	19.65	19.50	19.55	41.76	38.07	40.97	38.65	8.86
1.30	0.69	0.52	0.50	0.09	0.54	0.79	0.77	0.09	0.16
467.00	423.00	629.00	623.00	974.00	537.00	1015.00	1027.00	5620.00	2482.00
2496.00	2813.00	2037.00	1757.00	6245.00	4713.00	3934.00	4170.00	9653.00	9994.00
1.56	1.30	0.83	0.93	0.57	3.25	1.93	3.13	2.07	0.81
1.50	1.46	1.51	1.49	1.47	3.16	2.90	3.11	2.89	0.67
1.16	1.26	1.04	0.93	2.82	2.05	1.93	2.03	5.96	4.87
1.41	1.34	1.13	1.12	1.62	2.82	2.25	2.76	3.64	2.12

No standard mode; video driver requires enhanced mode.

Windows 3.1 applications did not execute. Excel results are for an experimental Mips version of Excel.

extensive device support scored a knockout. In the first week of its commercial release, I installed NT on four Intel systems: a Unisys 60-MHz Pentium-based 5606e, a Gateway 2000 4DX2-66E, an Everex Step 486DX2/50, and the 33-MHz PS/2 Model 90 XP 486. (A fifth machine, the ALR Flyer 32LCT 4DX2/66, lacked the RAM to run NT; with only 8 MB, it ran DOS/Windows and OS/2.) NT detected and automatically configured for every drive controller, video adapter, network card, and CD-ROM it encountered, with one exception—the Unisys-brand CD-ROM in the Unisys machine.

With OS/2, 18 months after the release of its first 32-bit version, the situation was quite different. On the Gateway machine, for example, OS/2 appeared to install happily but then turned in suspiciously poor benchmark results. There were two problems.

First, OS/2 does not, by default, detect and configure for SuperVGA controllers like the Diamond Speedstar 24x (Western Digital 90C31A accelerator) that came with the Gateway machine. You have to run a separate utility, `dspinstl`, to configure advanced video support.

Second and more troubling, OS/2 silently used its generic INT 13–based SCSI support to substitute for the Ultrastor 24F driver that didn't come in the box. That worked, but slowly, and precluded access to the Toshiba 3401 CD-ROM drive in the machine. The correct .ADD driver is available from Ultrastor; I downloaded and installed it, and then everything was fine. But the burden was on me, the user, to notice a problem with disk performance and take steps to correct it.

Why was the Ultrastor driver, if available, not bundled with OS/2? An Ultrastor spokesperson expressed frustration with IBM on this point, but also said that IBM's procedures are changing and that future versions of OS/2 should come with more complete bundled device support.

I also had to use `dspinstl` to activate OS/2 support for the embedded ATI Mach 32 controller in the Unisys Pentium machine and for the STB Horizon adapter (Cirrus Logic CL-GD 5426 accelerator) in the Everex system. Further, I had to acquire the .ADD driver for the Adaptec 7770 in the Unisys machine (which, in fairness, wasn't available in March when OS/2 2.1 shipped), and I learned that Ultrastor no longer offers specific OS/2 support for the 15C caching IDE controller in the ALR machine.

Finally, OS/2 did not, of course, even attempt to make use of the Ethernet adapters that were available in all the test machines. With OS/2, as with Windows 3.1, installation is all too often just the beginning of what can be a long and complicated journey. Although NT does not initially target the mass audience of desktop users that Windows and OS/2 do, it puts both those systems to shame when it comes to easy and comprehensive installation. Ironically, the system administrator who installs NT to run server applications for a department will probably have an easier job than the administrator or user who installs Windows 3.1 or OS/2 to connect to that server.

A Closer Look at OS/2

I began by running the OS/2 tests four times on each machine to account for all combinations of modes. There are a number of possibilities to consider. You can run a Windows 3.1 program seamlessly—that is, side by side with PM programs on the OS/2 desktop—or full-screen in a dedicated Windows screen session. Each Windows program can also run in standard mode or in what IBM calls 386 enhanced-compatibility mode. Finally, Windows programs can share a common VDM (virtual DOS machine) or run in their own separate VDMs.

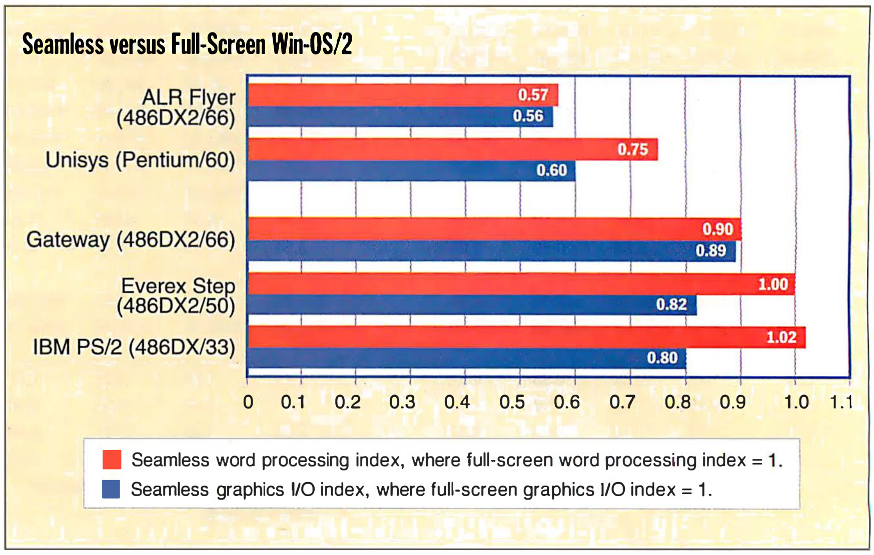
Since our application suite doesn't require that multiple Windows programs be concurrently active, I ran all the tests in a single shared VDM. However, I separately uncovered problems with DDE across OS/2 VDMs; for a description of these problems, see the text box "Win-OS/2 Subtleties: Enhanced-Compatibility Mode and DDE" on page 86.

Although I initially tested both standard and 386 enhanced-compatibility modes for both the seamless and full-screen cases, the standard/enhanced differences turned out to be insignificant. After IBM explained that the two modes are effectively the same, I settled on just one test for seamless display and one for full-screen display.

Seamless display does mean extra work for OS/2, so you'd expect that full-screen display would be best for graphics-intensive tasks. Interestingly, the five Intel systems cluster into two groups when you compare ratios of the low-level graphics index under seamless Win-OS/2 to the same index under full-screen Win-OS/2 (see the figure "Seamless versus Full-Screen Win-OS/2"). For the Unisys with its ATI Mach 32 controller and the ALR with its standard VGA controller, seamless display had no better than 60 percent of the performance of full-screen display. For the remaining three systems, seamless performance was 80 percent to 90 percent that of full-screen.

The word processing indexes, which register these variations in video performance, suggest that for systems with less capable Win-OS/2 drivers (like those in the first group), the seamless penalty when running an application like Ami Pro can be significant. By contrast, for systems with better Win-OS/2 drivers (like those in the second group), the penalty can be relatively insignificant.

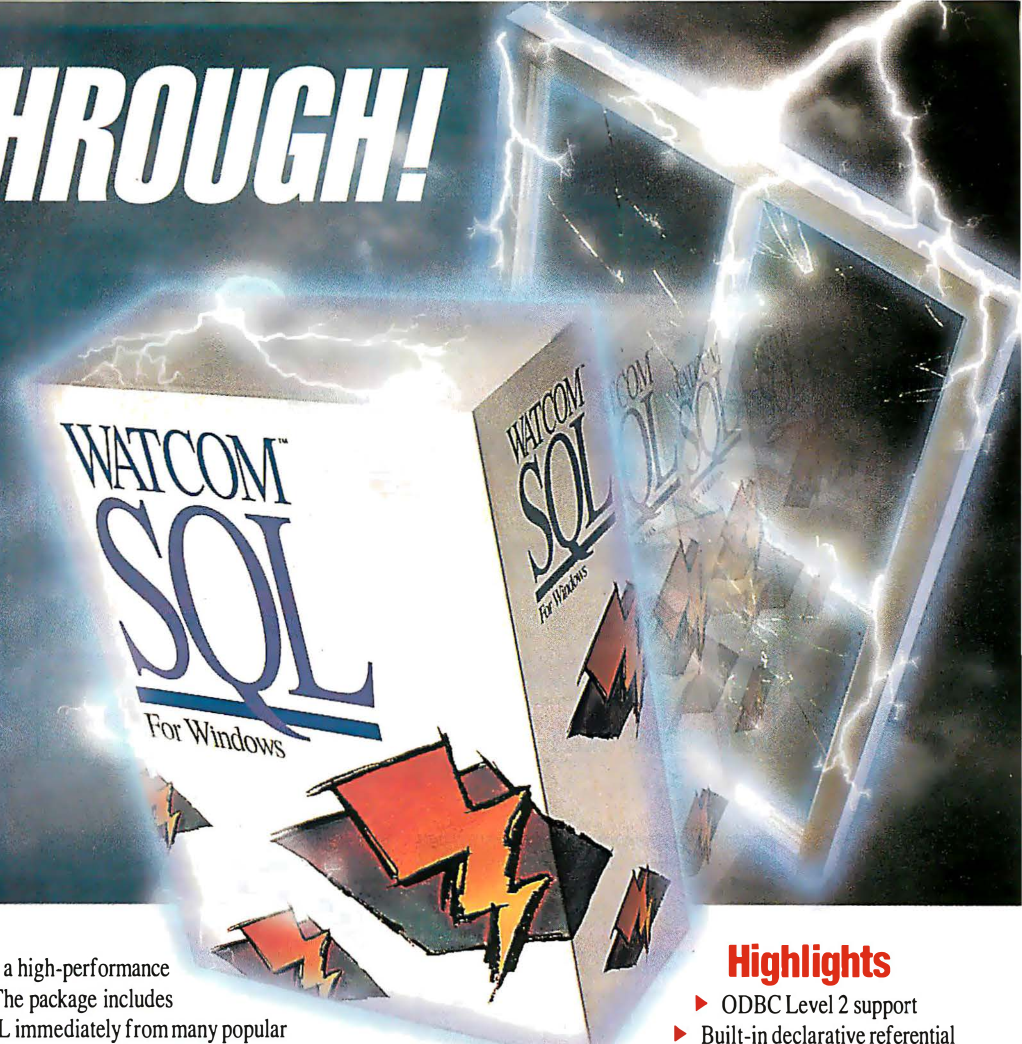
Looking at the Windows application



Ratios of seamless to full-screen *Win-OS/2 performance for five systems cluster into two groups. Systems with relatively weak seamless Win-OS/2 display drivers pay a significant penalty for seamless operation. Systems with stronger seamless Win-OS/2 drivers pay little or no penalty.*

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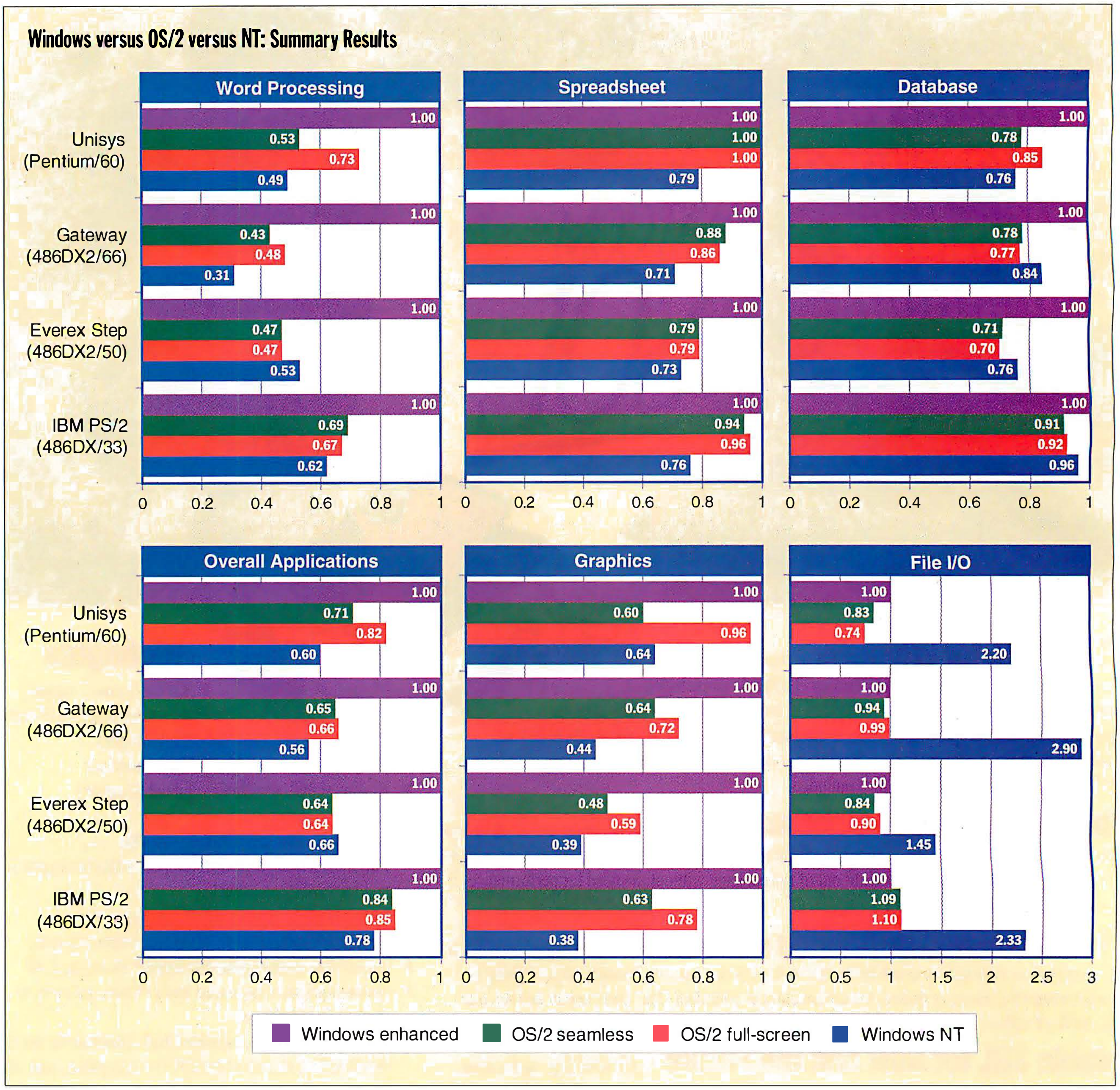
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On the application benchmarks, *OS/2 trails Windows by a wide margin, while NT in turn trails OS/2, although by a lesser margin. NT's prodigious disk performance dominates the low-level results, although the graphics numbers are disappointing.*

benchmarks across systems, OS/2 was a middle-of-the-road performer, generally a bit better than NT and a lot worse than Windows (see the figure "Windows versus OS/2 versus NT: Summary Results"). At best, on the PS/2, OS/2's overall applications index (using full-screen display) was 85 percent that of enhanced-mode Windows. At worst, on the Everex, it was 64 percent of Windows.

The Windows low-level benchmarks reveal some interesting details. For example, OS/2's enhanced FAT (file-allocation table) file system and robust disk cache often get credit for improving the performance of DOS (and therefore Windows) applications relative to what you can achieve under DOS equipped with SmartDrive or another DOS-based disk cache. On four of five systems, however, Win-OS/2's file I/O index lagged or, at best, didn't quite equal that of enhanced-mode Windows. The lone exception was the PS/2 system, on which Win-OS/2's file I/O bested that of DOS/Windows by 10 percent. Evidently, OS/2 on the PS/2 machine makes good use of that system's IBM SCSI-2 controller. Note, though, that NT—a shockingly good disk performer—more than doubled OS/2's score on the same PS/2 hardware.

The low-level graphics results show that OS/2's SuperVGA drivers exploit some accelerated chip sets spottily. OS/2's full-screen pixel- and line-drawing performance on the Unisys system's embedded ATI Mach 32 accelerator actually outdid Windows running ATI's Mach 32 driver, and OS/2's BitBlt performance lagged behind that of Windows by only about 10 percent. On the Gateway's WD 90C31A, however, OS/2's pixel- and line-drawing

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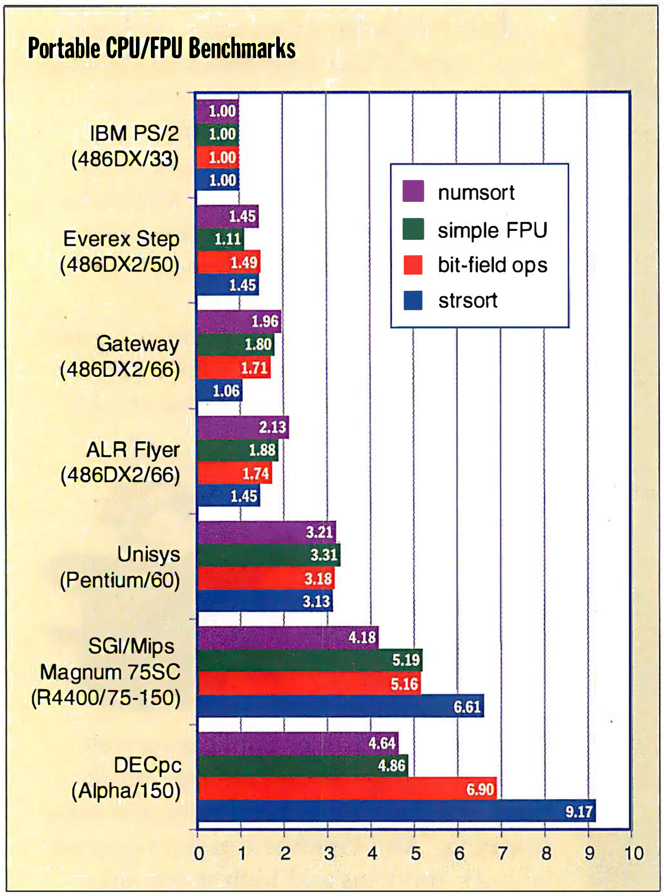
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BYTE's portable benchmarks *display raw CPU/FPU horsepower for five Intel systems and two RISC machines.*

numbers dropped noticeably, and the BitBlt function was nearly an order of magnitude slower than under Windows with the Speedstar 24x driver from Diamond. The same was true for the Everex's Cirrus Logic 5426; here, OS/2's BitBlt score wasn't even a twentieth that of Windows. On these same systems, however, NT fared even more poorly than OS/2.

The moral? There's more to accelerated SuperVGA support than just handling popular display resolutions and color depths. Both OS/2 and NT recognize and support a variety of SuperVGA chip sets, but their drivers don't always support the acceleration functions of those chip sets as comprehensively as the drivers that are available (though usually not bundled) with Windows.

NT's Maiden Voyage

Two striking findings emerge from the NT numbers. On the application benchmarks, NT trailed in nearly every case. (The gap between NT and OS/2 was much narrower, however, than that between OS/2 and Windows.) As always, there are various filters through which to view that result.

On the one hand, Microsoft hasn't vociferously made IBM's "better Windows than Windows" claim on behalf of NT. It can also say with some justification that Win32 applications (which can be very close cousins of Win16 applications) will soon alleviate pressure on NT's Win16 subsystem.

On the other hand, Microsoft admits that NT must run Win16 binaries well and has said that the API pass-through architecture that gives those programs access to NT's native Win32 subsystem would give Windows 3.1 performance under NT a major shot in the arm. It's likely that the pass-through has increased performance, and that performance would be even worse if NT had to rely for its Win16 support entirely on its VDM (as is the case with OS/2).

When you consider NT's overhead—the costs of protected subsystems, C2 security, portability, and Unicode—the surprising result may not be that OS/2 leads NT, but rather that NT doesn't lag by a wider margin. The fact remains that pure Win16 application performance is not a reason to prefer OS/2 over NT. Note, also, that NT will barely run on an 8-MB system like the ALR, a machine on which OS/2 performs admirably.

The second startling result is NT's tremendous performance on the low-level file I/O test. NT's unified cache manager aggressively exploits memory mapping and can use all available RAM not needed by applications. Evidently, the strategy pays off: NT's file I/O numbers range from one-and-a-half to nearly three times those of Windows. Indeed, the I/O index is so disproportionately large that it overcomes weak graphics results and causes NT to emerge as the overall winner on three of four systems on the low-level benchmarks.

When you want to run Windows 3.1 software . . .

- **Standard-mode Windows does it fastest.**
- **Enhanced mode runs a close second.**
- **OS/2 runs a not-so-close third.**
- **NT brings up the rear.**

For evidence of this effect at the application level, look at the disk-intensive remove subtest of the Superbase test (see the table on page 88). Here, NT consistently equaled or bettered both enhanced-mode Windows and OS/2. Clearly, these results bode well for NT not only on file and database servers but also on high-end workstations that must deliver industrial-strength I/O.

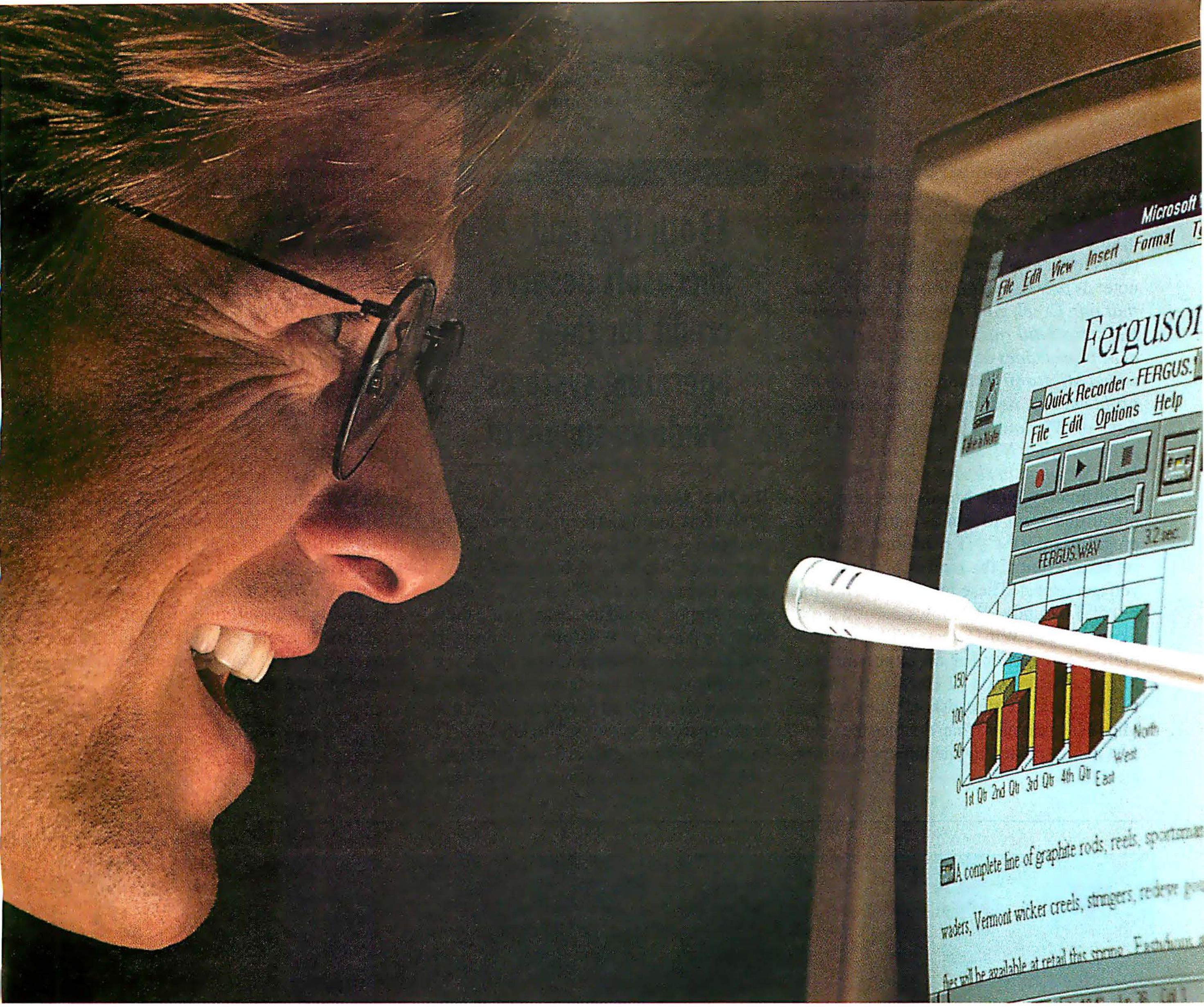
The RISC Dimension

Our RISC systems were a Silicon Graphics/Mips Magnum 75SC (75- to 150-MHz R4400, 32-MB RAM, SGI G364 frame buffer, and NCR 53C9X SCSI controller) and a DECpc AXP 150 (150-MHz Alpha, 64-MB RAM, Q-Vision video adapter, and Adaptec 1742 SCSI controller). The BYTE portable benchmarks indicate how these machines stack up against the Intel crowd in terms of raw CPU and FPU horsepower (see the figure "Portable CPU/FPU Benchmarks").

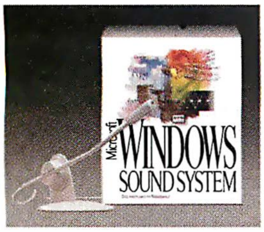
Note that NT was shipping for the Mips but not for the DECpc at the time of this review. Because the version of NT on the DECpc was an unoptimized debug build of the operating system rather than an optimized retail build, I have chosen not to report the application and low-level benchmark results for the DECpc. However, BYTE's portable benchmarks, which don't rely heavily on NT system services, do hint at the awesome potential of this machine.

The Mips Magnum's cumulative low-level Windows benchmark results place it ahead of all the Intel boxes except the Unisys—an impressive performance indeed. Application benchmarks, however, were a severe disappointment. While Ami Pro, Excel, and Superbase did load and operate interactively, all three applications fell flat on their faces when subjected to our test scripts.

Why did the low-level Windows benchmark succeed where the applications failed? Our staff-written benchmark is a vanilla Windows program that plays by the rules. Commercial applications almost always bend some of the rules, and the Mips version of NT's Insignia-derived emulator clearly won't tolerate such behavior. (Interestingly, two of the three scripts did complete, albeit slowly, on the DECpc.) Clearly, NT's Win16 compatibility on the



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Mips machine will have to improve. At the same time, however, the availability of RISC NT—an attractive, high-powered option—should induce Windows developers to rely less on dirty tricks. (Editor's note: *At press time, Microsoft informed us that our Excel, Ami Pro, and Superbase test scripts did run successfully on several Mips machines at Microsoft. We worked with a Microsoft technician to resolve the problem, but, despite several reinstallations of Windows NT, we could not pinpoint whether NT's configuration or the Mips Magnum itself was at fault.*)

Ultimately, your bread-and-butter applications want to run as native Win32 programs on RISC NT platforms. The Excel results hint at the kind of performance you can expect. These numbers are *not* for Excel 3.0a under Windows 3.1—which, like the other Win16 tests, did not complete—but rather for an experimental Mips-native version of Excel 4.0. Using those results, the spreadsheet index for the Mips Magnum more than doubles the next-best result (posted by the Unisys Pentium machine).

Both IBM and Microsoft deserve credit for their operating systems' Windows support.

The Final Analysis

Both IBM and Microsoft deserve great credit for the Windows support they have engineered into their 32-bit operating systems. But neither OS/2's nor NT's Windows support would entice me to use these systems purely as Windows platforms. If you can tolerate Windows on DOS, you probably should—it's faster even on machines well equipped to run the bigger and better operating systems. Use OS/2 or NT to deploy mission-critical 32-bit programs, and tap the 16-bit Windows software base for personal productivity. Their Win16 subsystems are plenty good enough for this.

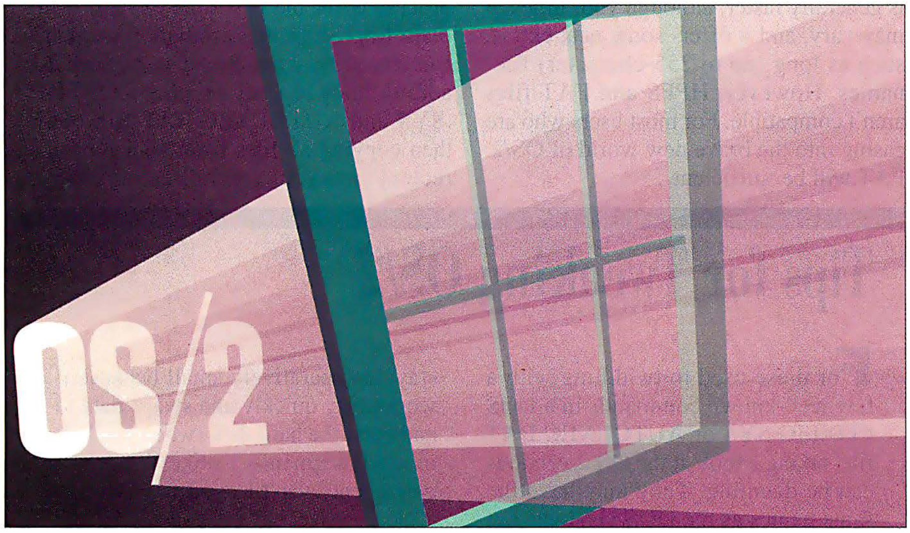
What about OS/2 versus NT? Comparing the two is really inappropriate. The apples-to-apples comparison would be Chicago versus OS/2, and the oranges-to-oranges matchup would be NT versus Workplace OS. But neither Chicago, which will be Microsoft's Intel-specific offering, nor Workplace OS, which will be IBM's portable offering, is shipping. That leaves the unfortunate but inevitable apples-to-oranges comparison of OS/2 to NT.

With respect to Win16 support, OS/2 has a performance edge and does well in 8 MB. NT handles DDE and OLE more reliably and needs double the RAM. Ultimately, of course, the choice will hinge not on Win16 support but on availability and quality of 32-bit line-of-business applications. Developers in both camps are hard at work, and we'll be following their efforts closely. ■

Jon Udell is a BYTE technical editor at large. You can reach him on BIX as "judell" or on the Internet at judell@bytepb.byte.com.

Circle 322 on Inquiry Card (RESELLERS: 323).

OS/2 2.1: A User's Perspective



DANIEL PELAVIN © 1993

STAN MIASTKOWSKI

For a few minutes, let's forget the politics, the personalities, and the seemingly interminable corporate bickering associated with The Great Windows versus OS/2 Controversy. The subject at hand is OS/2 2.1...from a decidedly user-oriented perspective. While it's tempting to throw down the OS/2 versus NT gauntlet, the more apt comparison for most PC users right now is OS/2 2.1 versus Windows 3.1.

If you're a Windows user attempting to make a decision on whether to make the move to OS/2, the obvious question is whether OS/2 2.1 really delivers a "better Windows than Windows" (as IBM is so fond of saying). The answer: a resounding "It depends." The more you do with Windows, the more advantages you can get from 2.1. If you place yourself in the power-user category, run numerous Windows applications simultaneously, are comfortable tweaking INI files, and still depend on multiple DOS applications, OS/2 2.1 offers many advantages. On the other hand, if you don't push Windows to its limits, you're just as well off staying with it.

Strong Foundations

Windows 3.1 and the Windows that runs in OS/2 2.1—dubbed Win-OS/2—are virtually identical. Windows compatibility also existed in OS/2 2.0. The problem was that it included Windows 3.0 at the same time that Microsoft was shipping 3.1. With OS/2 2.1, things are on a more even keel.

One of the biggest advantages that OS/2 2.1 offers is that Win-DOS runs on top of a true 32-bit operating system, using a 386 or 486 processor to nearly its full potential. OS/2 is a full-fledged preemptive multitasking operating system. Windows, DOS, and OS/2 applications all run in their own protected-mode sessions, guarded from the slings and arrows of overlapping application problems. If one crashes, the others are usually unaffected. (In certain circumstances, it is possible to lock up the whole system, but it happens considerably less frequently than in a DOS/Windows-based environment.)

A Long Installation

Both installing and using OS/2 2.1 requires time and commitment (at least initially). Getting up and running isn't simply a matter of copying a few disks. You should figure on at least half a day, and make a backup before you begin. There are many decisions to make along the way, too. The size of the installation task becomes apparent as soon as you rip open the shrink wrap. Buried under a couple of manuals is a pile of 25 3½-inch disks. (A 5¼-inch version is available, too, with even more disks.)

Are you feeling cramped by DOS/Windows? Give OS/2 a try.

If you have a CD-ROM drive, IBM also offers a CD-ROM version. But in order to install OS/2 2.1 directly from the CD-ROM (and be able to access the CD-ROM drive later), you'll need to have a true SCSI CD-ROM drive connected to a specific SCSI controller from Adaptec, Distributed Processing Technology, Future Domain, or IBM. There are a lot of nonstandard CD-ROM drives around with their own proprietary interfaces. IBM lets you use a nonstandard CD-ROM drive by first manually creating all 25 installation floppy disks (under DOS) from the files on the CD-ROM.

IBM says you'll need at least a 386SX and 4 MB of RAM. You'll definitely want more RAM and power, though, especially if you'll be taking advantage of OS/2's true multitasking capabilities. I found that a 486 (even an SX) and 8 MB of RAM is about the minimum to obtain acceptable performance. I finally settled on running OS/2 on a generic clone based on a 66-MHz 486DX2 along with 16 MB of RAM. You'll need a hefty hard disk as well. A full OS/2 2.1 installation requires about 29 MB of disk space.

continued

Take Your Choice

You can have the installation format your hard disk and start from scratch, choosing between the standard DOS FAT-based (file allocation table) file system or the HPFS (High Performance File System) that's unique to OS/2. HPFS offers some unique advantages, especially if you're using data-intensive applications such as databases. It is generally faster, although your mileage may vary, and it offers some neat extras, such as long (up to 255-character) filenames. However, HPFS and FAT files aren't compatible. For most users who are easing into the brave new world of OS/2, FAT will be sufficient.

If you decide to stay with FAT, you can use all the programs and data that are already on your hard disk. You can then also opt for the dual-boot feature that lets you boot either OS/2 2.1 or DOS at start-up. Being able to boot into your old familiar DOS environment is a comfort, but setting up your system for the dual boot is needlessly complex. To IBM's credit, the process is for the first time explained in plain English in the installation manual. But it requires a number of steps, such as adding lines to your existing CONFIG .SYS and AUTOEXEC.BAT files and then copying all files from your root directory into your DOS directory. Why couldn't it include a batch file to automate the process?

The Old Disk Shuffle

Installing OS/2 isn't a linear process. You have to reinsert various disks at various times. It's also during the installation that some of OS/2 2.1's limitations begin to show up. To get seamless Windows (i.e., the ability to run windowed OS/2, Windows, and DOS applications side by side) in something beyond 16-color standard VGA, you need to have a graphics card based on chips by ATI, Cirrus Logic, Headland Logic, IBM, Trident, Tseng Labs, or Western Digital. Or, you need to

Tips for Tweaking OS/2

For those used to twiddling with a few well-known commands in a DOS CONFIG.SYS or AUTOEXEC.BAT file, taking a look at the OS/2 versions can be daunting. They may have the same names as the DOS versions, but they're different beasts entirely. A "typical" OS/2 CONFIG.SYS file consists of 60 or so lines with a raft of unfamiliar commands such as THREADS, MAXWAIT, and TIMESLICE.

What to do? Luckily, the OS/2 installation does a great job of setting all these esoteric commands to what's best for your system. But if you must tweak, help is right at your fingertips. Just typing, for example, HELP THREADS at an OS/2 prompt brings up detailed graphical help that includes everything you need to know and even specific (and always helpful) examples.

A Couple of Cautions

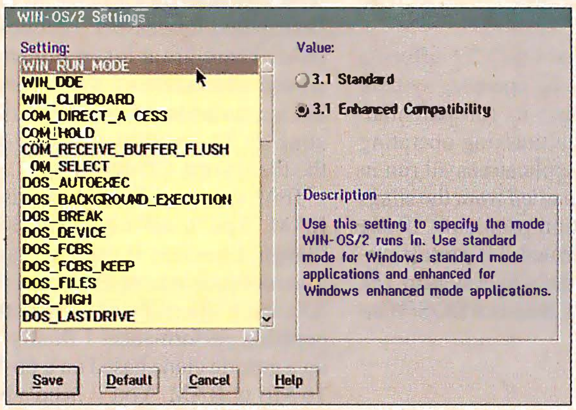
Caching—OS/2's built-in caching utility uses very little RAM for disk caching: 256 KB for an 8-MB system, and 512 KB for a 16-MB system. Although you might be tempted to increase that, it's best to leave it alone. OS/2 uses caching in a different and vastly more efficient way than does DOS. Your best bet is to leave the rest of the RAM for programs.

Swapping—OS/2's swap file is different from that of Windows. It's dynamic, expanding and contracting as needed, and usually stays comparatively small because it works very quickly and swaps data to and from the hard disk (when needed) in small segments. Unlike Windows' permanent swap file, you can't set it to a specific size, but you can specify the minimum amount of free space that it should leave in a disk partition. For the best performance, set the swap-file path for its own partition, although that requires some planning ahead.

Cleaning Windows

Win-OS/2, OS/2's version of Windows 3.1, is virtually identical to Microsoft's version. It should be; it's virtually the same source code. Win-OS/2 has its own WIN.INI and SYSTEM.INI files, and you're welcome to tweak away, just as you might under 3.1.

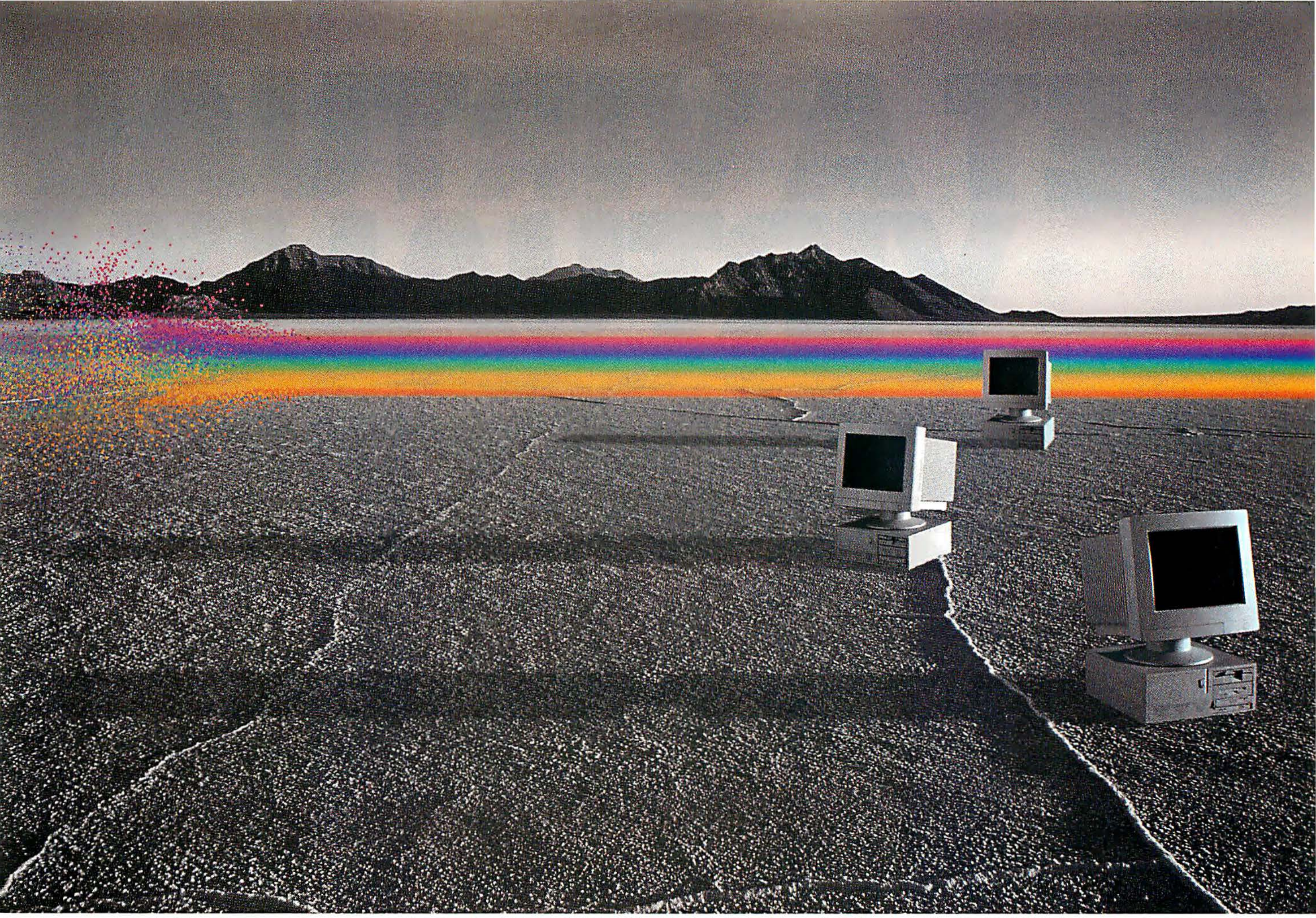
The key to maximizing Win-OS/2 performance is OS/2's unique settings screen, a menu of over 50 settings that can adjust just about any settings of Win-OS/2 that you can imagine (and many that you've never imagined). Best of all, you can set up different settings for different applications and different Win-OS/2 sessions. Each setting has its own detailed help available.



General Tips

Because OS/2 is so capable at doing lots of things at the same time, and because minimized program icons don't appear on the desktop, it's easy to lose track and end up with lots of concurrent programs dragging down system performance. What follows are some other helpful hints:

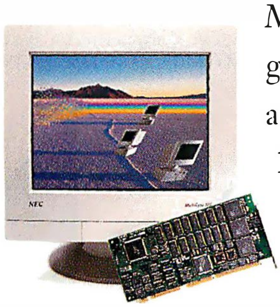
- If you're running a system with minimal RAM, say 4 MB, you should disable the default animation that's used to draw boxes in the Workplace Shell. Also, don't run multiple Windows sessions if you can help it. They absorb system resources like a software sponge.
- If you are running short on hard disk space, there are all sorts of OS/2 files you can live without. (For example, OS/2 comes with two different text editors.) The OS/2 manual does a great job of explaining every single file that's loaded during installation, and it tells you what isn't essential for what you're doing. It's a great way for you to save megabytes.



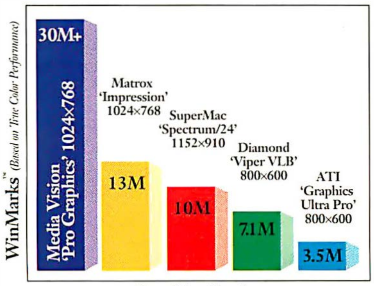
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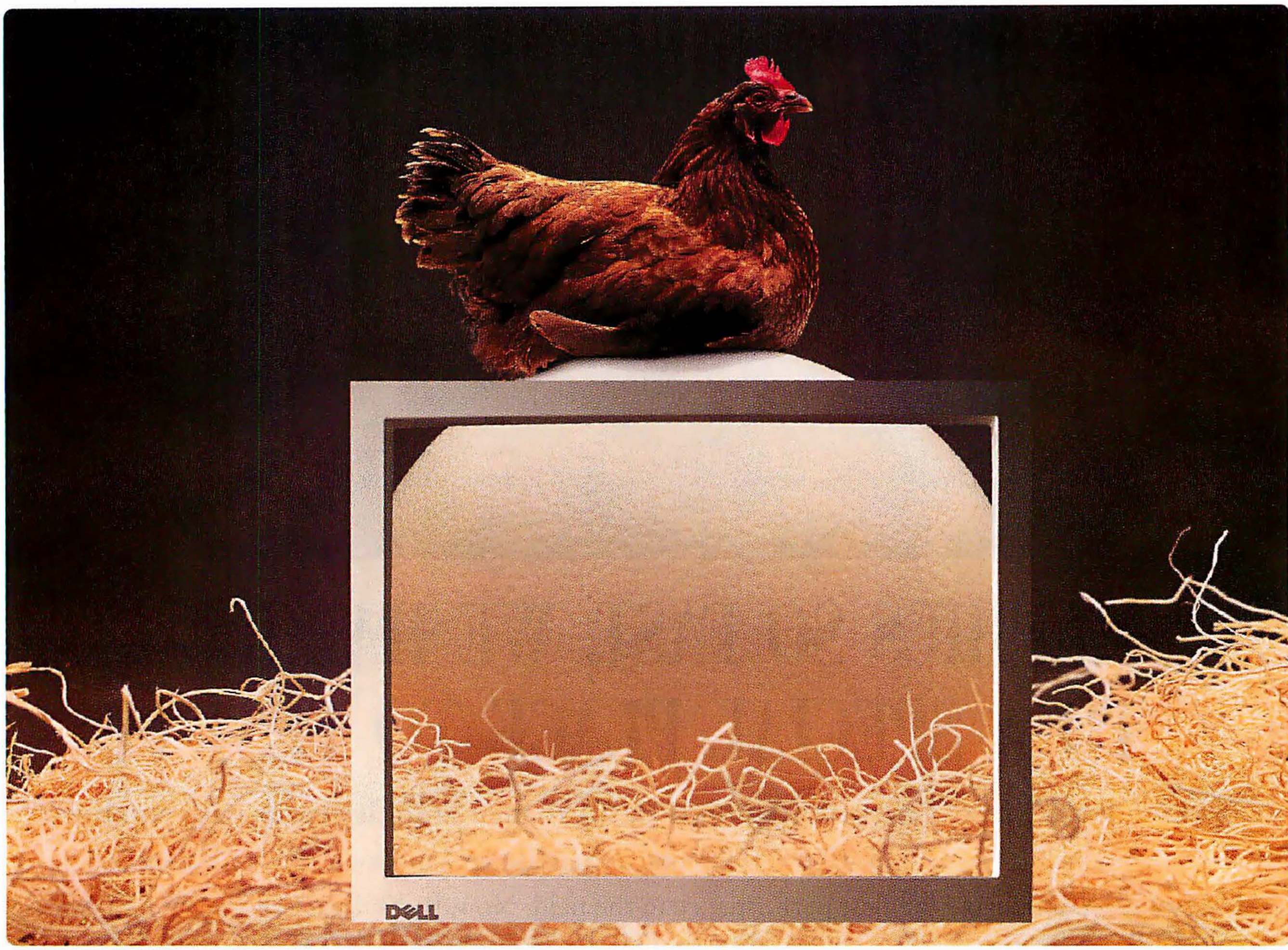
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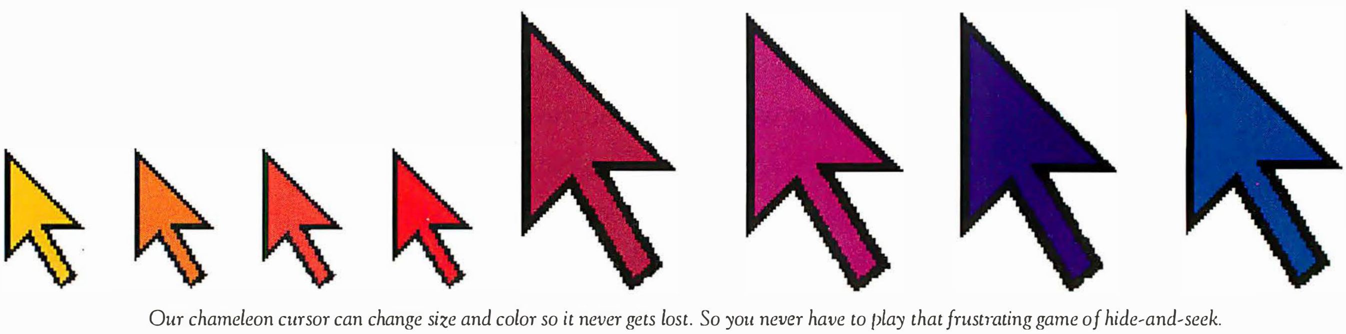
Tests performed using Ziff Davis Labs' WinBench™ V.3.11 without independent certification by Ziff. Media Vision conducted all tests based on Diamond motherboard with Intel 486DX2/66 CPU, 16MB RAM, 256K cache, 340MB IDE hard drive, MS-DOS Version 5.00.

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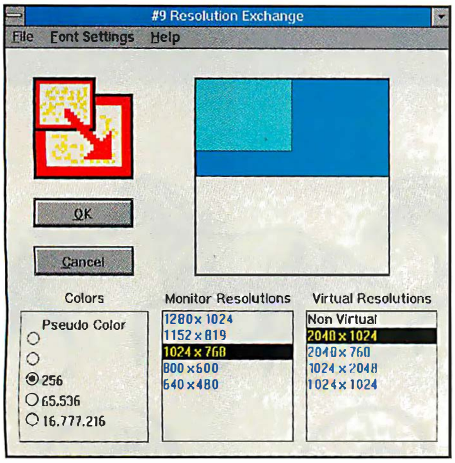


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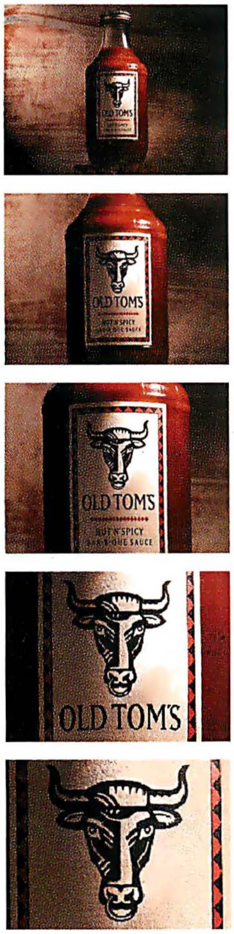
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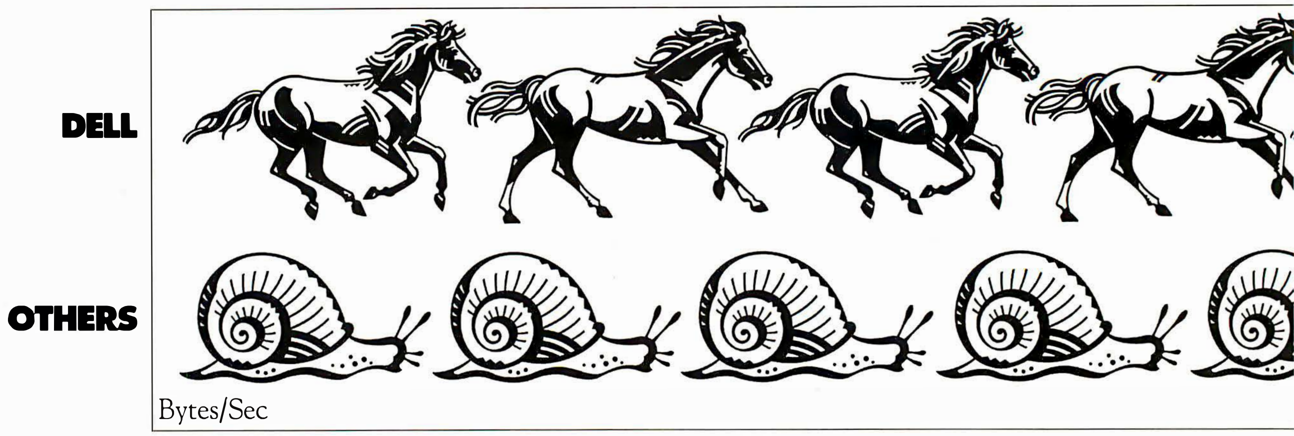
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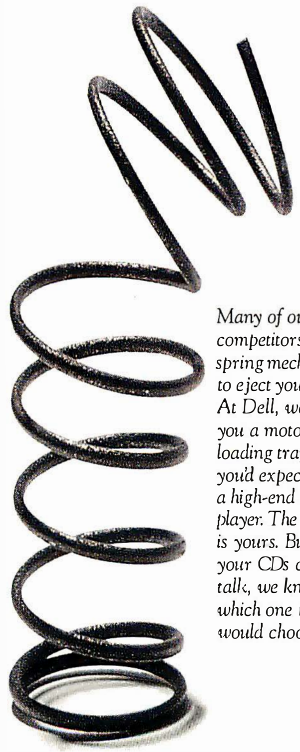
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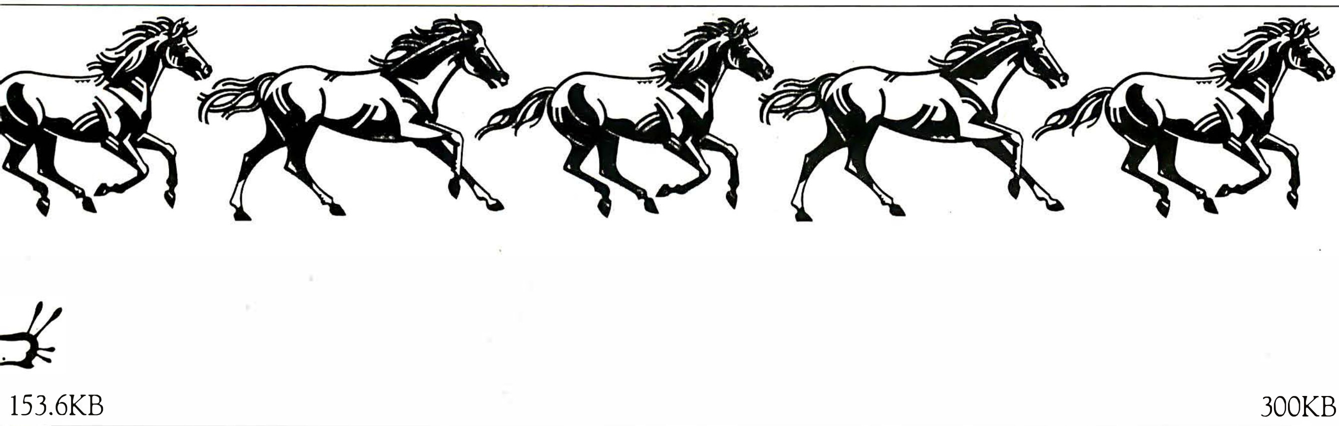
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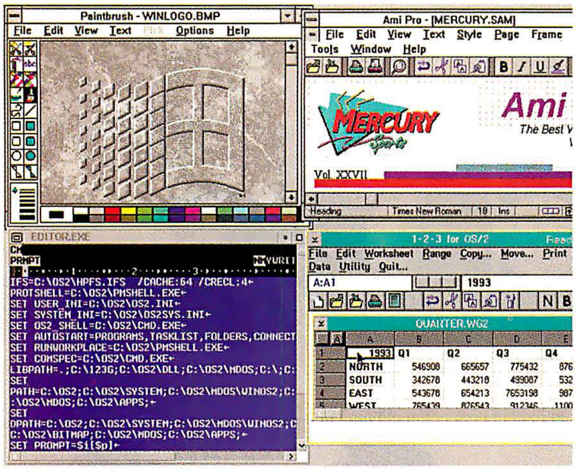
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Seamless Windows. *OS/2 2.1 can run Windows, OS/2, and DOS applications concurrently. True preemptive multitasking means they're all running and not in a state of suspended animation.*

have OS/2-specific drivers from the graphics-card maker. These are becoming more common. For this review, I used a Radius XGA-2 board designed specifically for OS/2. I also tested beta drivers with a high-speed Matrox board and beta drivers for the Diamond Viper board. A fast graphics board and OS/2-tuned drivers can result in some impressive video performance.

The final step in the installation is "migrating" both Windows and DOS applications to OS/2. The applications themselves aren't changed; essentially, folders and icons are created for the OS/2 desktop. Some common non-OS/2 applications require fine-tuning to run to best advantage in the OS/2 2.1 environment. OS/2 2.1 comes with a Migration Database that contains settings for many applications, taking advantage of the fact that each VDM (virtual DOS machine) in which a Windows or DOS application runs can have its own settings. (You can also migrate non-OS/2 applications later, or just install them directly from the OS/2 environment.) An IBM spokesperson says the company plans to update the migration database regularly. It will be available on major BBSes and on CompuServe.

Exploring the Workplace

When you finish installing OS/2 2.1, the moment of truth finally arrives: rebooting into the environment. What you see on the screen is vastly different from Windows' irritating-yet-familiar Program Manager. Initially, you can think of the Workplace Shell as a cross between the Macintosh desktop and Norton Desktop for Windows. But it's much more than that. The WPS is almost infinitely customizable and can be clean or cluttered, depending on your work habits. You can have icons for applications and folders. And the WPS is hierarchical, too; you can have folders within folders ad infinitum. Unique to the WPS is its ability to *shadow* icons—to create multiple icons for the same application that can reside in multiple locations on the desktop (e.g., in multiple folders).

The WPS is also object-oriented with a vengeance. You've heard that before, but this is the real thing. Icons, folders, and even the blank space on the WPS are all true objects. You can drag and drop to your heart's content. And you'll need to exercise that long-neglected right mouse button. When you point to any object on the screen and click the right-hand button, up pops a list of common tasks associated with that object. It makes a great deal of sense, but it also takes getting used to.

Virtual DOS Reality

If you are a creature of confirmed Windows habits, you can click on the Win-OS/2 Full Screen icon and work away in 3.1 Program Manager while completely ignoring OS/2. That's fine, but the real edge of OS/2 2.1 is in its true multitasking capabilities. From within the WPS, you can click on any application icon—Windows, DOS, or OS/2—and OS/2 starts it up. It's possible to have multiple Windows, DOS, and OS/2 sessions all running concurrently. In fact, that's the major advantage of OS/2.

The ability to have multiple Win-OS/2 sessions running concurrently isn't hard to see. You can, for example, have Procomm Plus doing a high-speed file transfer in one Windows session while Excel is doing some heavy calculations in another. They don't get in each other's way. And while all this is going on, you can also be formatting a floppy disk under OS/2 and perhaps running a dBase sort under DOS. Admittedly, the system I used for this review is powerful, but I didn't begin to see any degradation of performance until I had six major applications running concurrently.

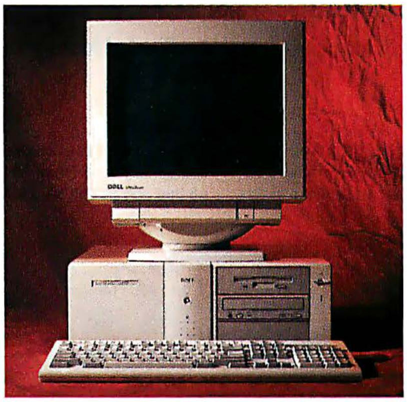
For those of us who occasionally still run old favorite DOS applications, OS/2 is particularly powerful. You can run gobs of separate VDM sessions. And each can have separate CONFIG.SYS and AUTOEXEC.BAT files, as well as numerous other customized settings. The same holds true of Win-OS/2 sessions. (See the text box "Tips for Tweaking OS/2.")

VDMs aren't perfect. They don't, for example, let you run block device drivers such as those used by my Bernoulli PC-Powered MultiDisk 150, which uses a proprietary SCSI interface that isn't supported under OS/2. In addition, I couldn't run the drivers for the LANtastic 5.0 network operating system. There is, however, a

ADVANTAGES	DISADVANTAGES
• Multitasking: True preemptive multitasking walls off applications from each other. • Workplace Shell: This truly object-oriented graphical interface is like a cross between the Mac and Norton Desktop for Windows. • Windows anywhere (or DOS or OS/2): Start any application from anywhere in Windows, DOS, or OS/2. • Capable Interapplication Communication: Clipboard and DDE work between all Windows and OS/2 applications. • On-line help: Just about everything you need to know is a couple of mouse-clicks away. • Advanced multimedia: True multitasking makes multimedia easy and powerful, supporting IBM's Ultimedia. OS/2 2.1 supports Sound Blaster and Media Vision sound cards and plays digital video at up to 30 frames per second in up to 320- by 420-pixel resolution. The CD-ROM version of 2.1 includes a considerable collection of sound and video files.	• No 32-bit Windows support: OS/2 is a 32-bit operating system, but it won't run 32-bit Windows applications and Windows VxDs (virtual device drivers). IBM says a solution is on the way. • Missing drivers: Version 2.1 has more built-in drivers (e.g., CD-ROM, SCSI, and graphics) than ever before. But you still can't be sure that your peripherals will work to best advantage with OS/2. And some peripheral makers have no plans to make drivers available. • Workplace Shell: Even though this also appears under Advantages, it can be needlessly complicated to figure out how to use the GUI. Common operations are sometimes buried deep in confusing layers of object orientation. Plus it's too easy to lose track of what's where and what's running. • Wimpy applications: The Productivity Applications included with 2.1 are a misnomer. Wipe them off the disk and get real applications. • Dual-boot setup: It works well, letting you switch back to your original DOS-based system. But setting it up is a needlessly complicated manual process.

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A GUIDE TO THE WORKPLACE SHELL

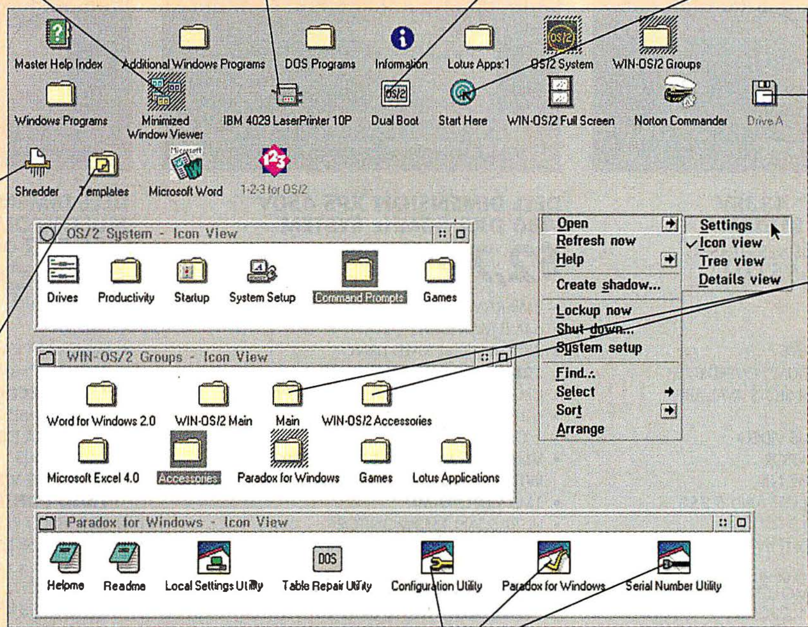
The Workplace Shell is aggressively object oriented. Point anywhere, even on a blank area (as shown), and click on the right-hand mouse button; up pops a menu of associated choices. Shaded icons mean an application (or application in the group) is running in the background.

MINIMIZED WINDOW VIEWER
To keep the Workplace Shell look and feel clean, minimized applications aren't arranged across the bottom of the screen as in Windows. Instead, the icons are tucked into their own folder. (If you'd really prefer the Windows method, you can change it.)

PRINTER ICON
Want to print a file? Just drag the file icon and drop it on the printer icon. It also gives you the print-queue status.

DUAL BOOT
Clicking on it closes all running applications and boots your original version of DOS (if set up that way during installation).

START HERE ICON
This icon tells you just about everything you need to know the first time OS/2 appears on your screen.



DISK A
It accesses the floppy drive.

SHREDDER
The name is a misnomer. It's just like the Mac Trashcan. It erases files, but you can also recover them.

FOLDERS
This is a hierarchical approach, just like the Mac Desktop. Organize applications and data in as many layers of folders as you wish. It's the graphical equivalent of subdirectories.

TEMPLATES FOLDER
Templates are predefined objects for the Workplace Shell for programs, data, printers, and so forth. Each type has a stack of templates you peel off (like a sheet off a pad) and drag and drop to a location in the Workplace Shell or in a folder. Then you click on the right-hand mouse button and customize the settings. Templates save gobs of time when you're setting up new applications.

PROGRAM ICONS
Any Windows, DOS, or OS/2 applications. OS/2 starts them directly. (No need to enter Win-OS/2 to run Windows applications.)

way to get around the problem, at least partially. You can boot a "true" DOS image and use drivers that aren't supported under OS/2's VDMs. The process is comparatively complex. You first create a bootable DOS disk on another computer, then copy FSFILTER (a DOS device driver that provides access to OS/2 partitions) to it, use VMDISK to create an image of a disk on your OS/2 hard drive, and finally create a new object for the DOS session. It works, but you get access only to the devices from within the DOS session under OS/2.

The 32-bit Question

The future of true 32-bit applications for the OS/2 environment is a mixed one. Although OS/2 applications are becoming more prevalent, few yet take advantage of the OS/2 internal power and multithreading capabilities. Some (e.g., WordPerfect for OS/2) are 16-bit ports of Windows applications. But true 32-bit applications (e.g., Lotus Ami Pro for OS/2) are now appearing. Their performance is impressive when compared with Windows.

More thorny is the question of the future of 32-bit applications under Win-OS/2. When I wrote this, Win-OS/2 didn't support Windows 32-bit applications and VxDs (virtual device drivers). At the present time, most applications are compatible under OS/2 2.1. And because Windows for Workgroups uses VxDs, you can't use it with OS/2. Help should be on the way; IBM expects that an OS/2 2.1 upgrade will appear "by the end of the year" to handle this. In the meantime, however, you're definitely out of luck. And, as mentioned, the question of longer-term OS/2 compatibility with future versions of Windows remains up in the air.

Let's get real. OS/2 2.1 isn't going to push aside Windows. Windows has too large an installed base. But neither will Windows destroy OS/2 2.1. OS/2 has some tantalizing advantages that make it ideal for true PC power users, especially in the corporate environments that IBM knows and loves. After years of development and testing and six versions, IBM should finally take a few well-deserved bows for OS/2 2.1. For PC users who need true preemptive multitasking, OS/2 makes a solid choice. ■

Stan Miastkowski is a BYTE consulting editor. He was cofounder and publisher of the OS/2 Report *newsletter and has been an OS/2 user since version 1.0. You can reach him on BIX as "stanm," on the Internet at stanm@bix.com, or via MCI Mail at 530-9979.*


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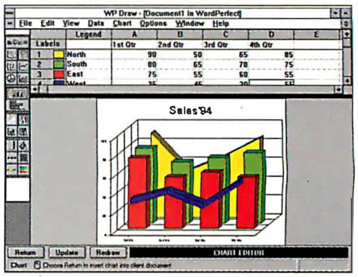
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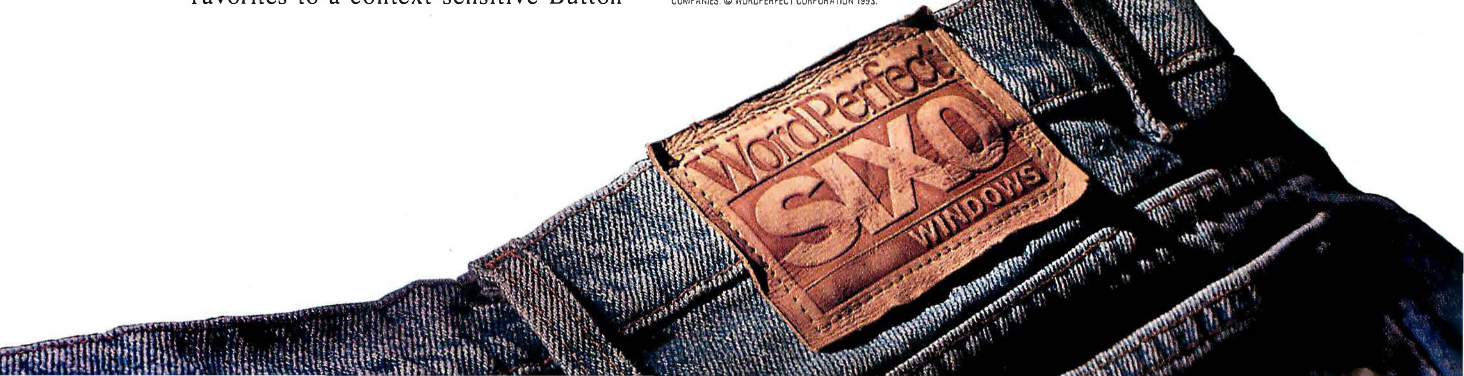
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Partners Seek to Unite Phone and PC

The Windows Telephony API promises a new generation of phone-enabled applications for the desktop

ANDY REINHARDT



Applications

Despite their obvious affinity, the two most essential pieces of equipment in today's offices, the computer and the telephone, have yet to be fully integrated. The gap has not gone unnoticed by vendors, but old habits and technology have kept the worlds apart.

Now, as part of its ongoing WOSA (Windows Open Services Architecture) initiative, Microsoft is trying to bridge this gulf. Following the front-end/back-end model the company has used in other WOSA components, Microsoft and its partners have designed a set of software interfaces that will facilitate connecting Windows systems to phone equipment.

The goal of the Windows Telephony API, or *TAPI*, is to enable a new generation of telephone-enabled software applications, while at the same time making it easier to connect desktops, laptops, and LANs into phone systems and PBXes. TAPI defines a client-side API that supports telephony features and a back-end SPI (service provider interface) that defines how phone equipment talks to a Windows DLL. When implemented, TAPI will let you access sophisticated central phone functions from your PC and let developers create phone-based programs without having to worry about the intricacies of the device on the other side of the interface.

Helping Hands

Microsoft's partners include phone-equipment vendors Northern Telecom, Alcatel, and Rolm; call-processing system makers Dialogic, Natural Microsystems, and Octel; software vendors Lotus, Delrina, and Contact Software; chip makers Intel, National Semiconductor, and Analog Devices; and RBOCs (Regional Bell Operating Companies) Ameritech and US West. Together, these companies are redefining the physical and logical connection between phone and PC. Soon you may have both devices on your desk, attached to a PBX and operating under the control of desktop software. In the future, telephone hardware could become integrated into the PC, and a handset could become a standard PC accessory.

In either scenario, the PC display will be the user interface to the phone system. To place a call, you could select a recipient from a pull-down list, and the phone number would be routed out through the PBX or switch. If you have a separate desktop phone, the PBX would ring it when the connection is made. Similarly, taking advantage of the Caller I.D. capability that identifies the phone number of an incoming caller, the PBX could feed the number to a database that would look up the caller's record and send it to your screen while the phone rings.

Much of the motivation for TAPI is the growing complexity of today's phone systems. Many users don't take advantage of sophisticated features such as Call Forwarding because they can't figure out how to use them. Providing access to these capabilities through the Windows interface could make them easier to use. For example, you could set up a conference call by dragging and dropping the names of all the participants into a box on the screen, leaving the PBX to place the calls.

An attractive potential application of TAPI would be a unified "in box," where E-mail, fax, and voice-mail messages are presented. This would eliminate an annoying aspect of voice mail: the need to listen to all the messages in a linear fashion. With Caller I.D. and a database of known numbers, incoming messages could be listed by the name of the caller, letting you retrieve them in any order. Using the same kinds of filtering software now available for E-mail (e.g., BeyondMail), you could prioritize voice messages or specify that calls from certain people be forwarded to another location.

Adding the LAN

For the time being, TAPI assumes that each client system is linked directly into the PBX or phone switch. It also requires that the software to implement phone capabilities be installed on every client, which could cause big companies with tens of thousands of users to think twice about the cost of buying it.

To better address the installed base, Novell and AT&T have established a nonexclusive partnership to connect NetWare servers and AT&T Definity switches. This server-based approach would allow the same kinds of features described above—dialing out directly from the client (routed through the server to the PBX) or looking up incoming Caller I.D.s in a server database—but would distribute the cost of telephony software across all network nodes. One major advantage of a LAN-based solution is that the PBX and LAN user directories may be integrated and centrally managed. It could also eliminate the need for separate network and telephone wires to each workstation.

The Novell/AT&T and Microsoft solutions are not necessarily incompatible: You could apply client-side TAPI applications in a NetWare environment through AT&T switches. Sue Rubinstein, a senior research analyst for the

Meta Group (Reston, VA), says that Microsoft's architecture "is more end-user oriented, for voice-enabled applications sold through retail." She argues that the Novell approach will be preferred by corporate customers because it fits in better with today's installed base of network and telecommunications equipment.

In the future, Microsoft is expected to supply a server-based solution that runs on the NT Advanced Server. Although both companies have said they are not competing for the same market, Rubinstein disagrees. "They're coming at it from two different directions," she says, "but they'll absolutely be competing head to head within two years."

The problem with the LAN-based approach, notes Frank Dzubeck, president of Communications Network Associates, a Washington, D.C., consultancy, is that today's networks aren't designed to handle real-time voice traffic. While Dzubeck believes telephony functions will appear immediately in notebooks and PDAs—typically in wireless implementations—they won't become common in the desktop environment until voice can be carried well across LANs.

Whither the Phone?

Dzubeck agrees with Rubinstein that the Novell/AT&T solution is now more attractive to customers. "Companies aren't going to throw away their PBXes, so they'll want to tie them to servers," Dzubeck says. But later in the decade, especially with the rise of desktop videoconferencing, those PBXes will be replaced with video servers and ATM switches, affording great risks to the established suppliers and an opportunity for new players. Instead of sophisticated, proprietary hardware devices, phone "systems" will become software modules running on off-the-shelf servers and local data/voice/video switches.

The same holds true on the desktop: If telephones migrate from stand-alone devices into PC peripherals, established players could lose their shirts. Rubinstein points out that there is no need for a fancy desktop phone with lots of buttons and an LCD display if all of its features can be accessed from a Windows desktop. So, vendors of phones will have to learn to sell PC add-ins and software to computer owners.

Another wild card in the path to acceptance for TAPI is General Magic's Telescript, an interpreted language that aims to do for telecommunications what Adobe's PostScript did for printing. Telescript defines an architecture for communication of rich data types transparent to underlying protocols and media. Through the use of "agent" objects, Telescript goes well beyond merely integrating today's PCs into the phone system: It defines an intelligent subsystem for establishing and routing communications among users and processes. Given its backers, who include AT&T, Apple, and Motorola, Telescript may find its initial acceptance in mobile applications, but it could eventually become standard middleware between the client Windows interface and back-end services ranging from local switches to the information highway. ■

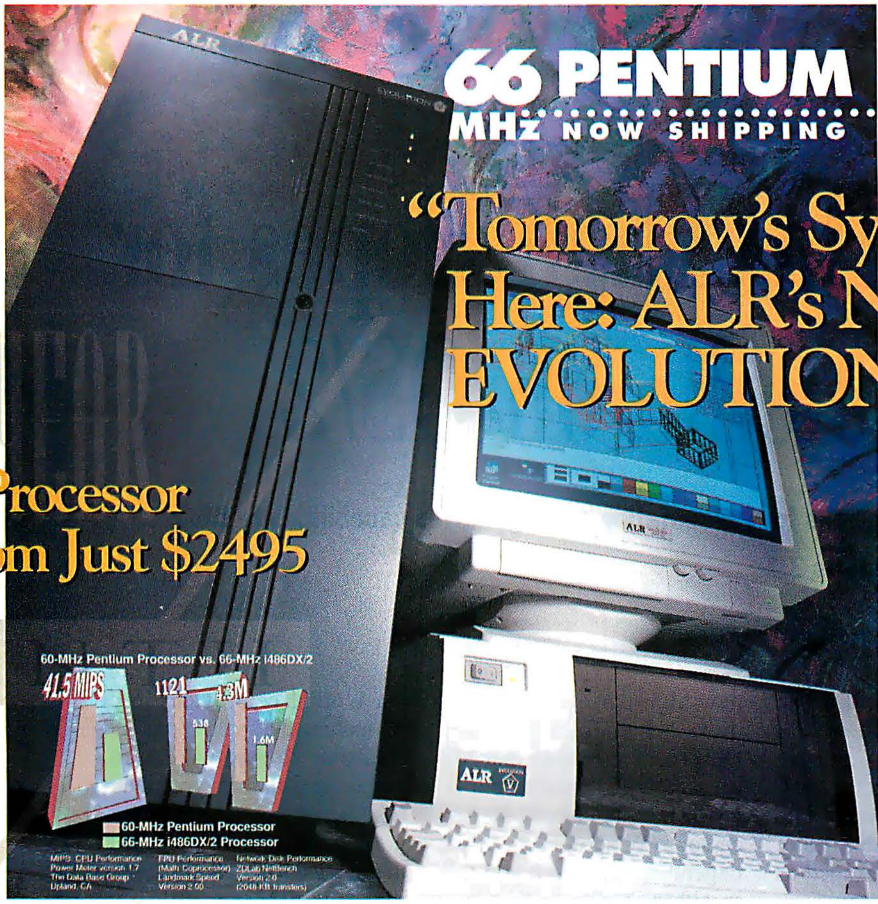
Andy Reinhardt is BYTE's West Coast bureau chief. You can reach him on BIX as "areinhardt."

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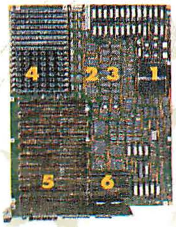
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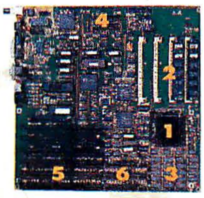
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IBM Has High Hopes for Multimedia on OS/2

Multimedia Extensions for Presentation Manager gives capabilities to OS/2 that outstrip Windows 3.1

NICHOLAS BARAN



Applications

IBM faces an uphill battle in its effort to make OS/2 a major player in the PC operating-system arena. But the company has a clear advantage with the multimedia capabilities of OS/2, which are packaged as the Multimedia Extensions for Presentation Manager (or MMPM/2 for short).

This advantage comes in part from OS/2 features such as 32-bit bandwidth and preemptive multitasking. These features enable the operating system to handle simultaneous multiple video and audio sources as well as the demands of video and audio synchronization and high-speed video frame rates that are required for digital movies.

Windows 3.1, on the other hand, does not offer the performance or the robustness to handle sophisticated multimedia applications. (For a detailed comparison of multimedia on Windows 3.1 and OS/2, see "Multimedia Infrastructures," August BYTE.) In spite of the software's limitations, however, Microsoft has focused its multimedia program on Windows 3.1 and has not done much to promote multimedia for its new high-performance Windows NT operating system. Observers speculate that Microsoft will promote multimedia heavily in its 32-bit successor to Windows 3.1 (called, depending on whom you talk to, either Chicago or Windows 4), which is due out sometime next year.

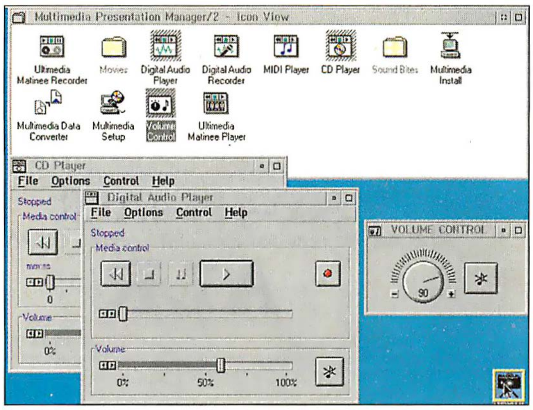
Window of Opportunity

In the meantime, IBM is aggressively pushing OS/2 for multimedia. In the past few months, IBM has announced a series of multimedia development tools, under the moniker *Ultimedia*, that work with MMPM/2.

Ultimedia Builder allows you to build multimedia presentations. Ultimedia Perfect Image is an image-processing tool for editing and enhancing captured images. And Ultimedia Workplace provides links for multimedia applications and databases so that you can incorporate data from your database into multimedia presentations. In addition, IBM is about to release a tool called Ultimedia Video IN for capturing video footage and converting it into a sequence synchronized with audio.

All of these tools support IBM's Ultimotion data-compression algorithm; in addition, they also support other major data-compression algorithms, such as SuperMac's Cinepak and Intel's Indeo. It is also interesting to note that IBM is porting its Ultimotion algorithm to Windows.

But while few would dispute that IBM's multimedia offerings are superior to what is currently available from Microsoft, there's considerable concern about OS/2's installed base. Says Joe Scirica, vice president of product development at Maxis (makers of the popular SimCity game for the Mac and Windows), "The OS/2 market is still too small. The installed base isn't large enough for us to support OS/2. Where's the OS/2 section in the software store?"

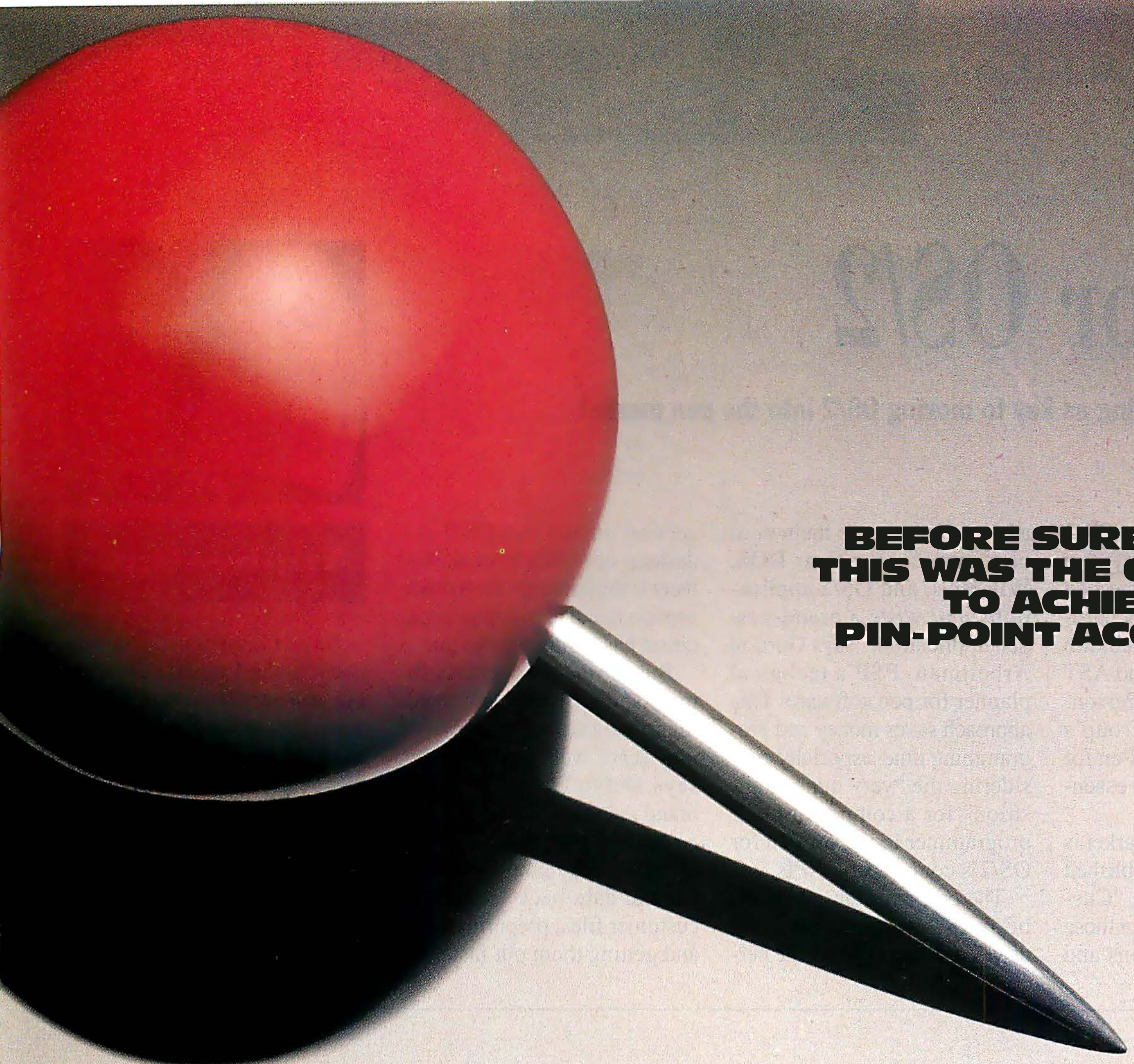


Multimedia Extensions for Presentation Manager.

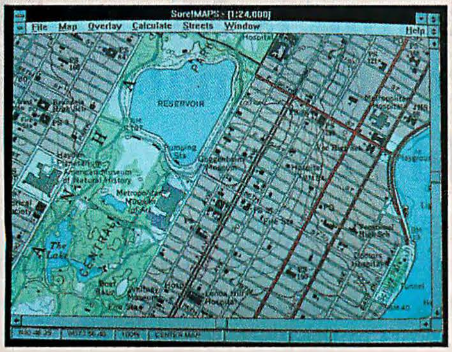
While OS/2's small installed base might scare off the game makers, IBM says that it is making headway with corporations that want to use multimedia for computer-based training and video E-mail and conferencing. For example, Holiday Inn is designing a multimedia training system for its desk clerks using OS/2 multimedia.

IBM's brand manager for multimedia, Karl LaWall, observes that "people who are beginning to use multimedia are discovering they need a robust platform—we're seeing increased acceptance of OS/2 across all areas of [the multimedia] marketplace." ■

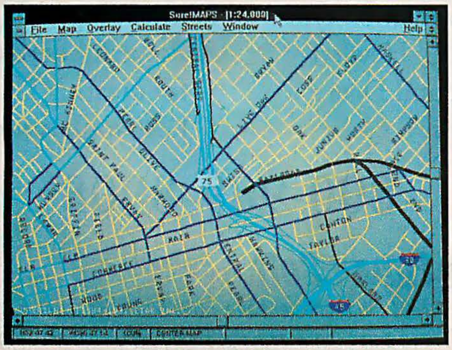
Nicholas Baran is a BYTE consulting editor living in Sandpoint, Idaho. He is the author of Windows from the Keyboard *(John Wiley & Sons, 1993). He can be reached on BIX as "nick-baran."*



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Pen for OS/2



Applications

IBM sees multitasking as key to moving OS/2 into the pen market

ED PERRATORE

IBM first had to make OS/2 the robust operating system users expect. Then came pen capability, supported by hardware makers such as Dauphin Technology, Telepad, and AST Research. Now for the Personal Systems Products group's next challenge: selling Pen for OS/2 horizontally in an essentially vertical market.

IBM's chief target market is the company's long-established base of existing users. "Customers want either to take those custom-built applications and add pen function to them or to continue running their DOS, Windows, and OS/2 applications *and* write a brand-new pen application," says Gordon Arbeitman, PSP's technical planner for pen software. This approach saves money and programming time, especially considering the "very minor transition" for a competent OS/2 programmer to master Pen for OS/2's controls and APIs.

The problem? Despite notebook PCs with bigger hard drives and more RAM, the perception lingers that OS/2 is a desktop operating system. And there is the better-grounded perception that handwriting recognition has a long way to go.

But for mobile workers using standard forms and needing to multitask, Pen for OS/2 may serve well. For example, says Debra Davis, PSP pen brand manager, if you're a meter reader filling out a pen-driven form, "you could be sending the data back, accessing customer files, preparing bills, and getting them out faster."

Says Gerry Purdy, Dataquest's chief mobile computing analyst: "It may end up, for a mission-critical application, to be the kind of operating system that is absolutely right on. You can't get that [yet] from Microsoft." ■

Ed Perratore is a BYTE news editor based in New York. You can reach him on BIX as "eperratore."

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IBM Makes MP Promises for OS/2

By adding symmetrical multiprocessing to OS/2, IBM has brought scalability to its premier desktop operating system

ED PERRATORE



Applications

Multiprocessor-capable hardware is a waste if your software is unable to use more than one CPU at a time. One major criticism of OS/2 has been its lack of support for multiprocessing. IBM plans to rectify this situation with OS/2 SMP, an operating-system enhancement due to go into beta by year's end.

IBM expects OS/2 SMP to turn in performance numbers superior to SMP performance on kernel-based operating systems. According to OS/2 developer Dave Medina, OS/2 SMP lacks much of the baggage of message passing and other overhead required to enable SMP on kernel-based architectures. This could mean a performance advantage for OS/2 over Windows NT and IBM's forthcoming Workplace OS when compute-intensive applications are run on a multiprocessing system.

OS/2 SMP makes no distinction between operating-system threads, such as the Workplace Shell or the Windows Manager, and those of the applications, says OS/2 SMP development manager Ayodele I. Anise. And DOS and Windows applications as well as those for OS/2 will be supported. Multithreaded applications will benefit the most, of course, because the various threads can be dispersed among available processors.

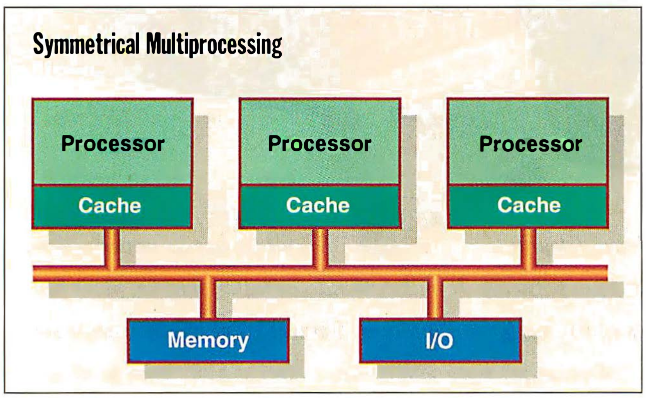
Ensuring Compatibility

By the time the code goes into beta, IBM hopes to have overcome difficulties created by certain OS/2 ISVs (independent software vendors) who, in the words of John Navas, a consultant working with alpha OS/2 SMP code under contract with Everex, "have written code that makes a lot of assumptions that are tied to a uniprocessor." Such software can very easily get into race conditions, where two pieces of code in the same application deadlock over simultaneous attempts to access the same resource. For example, the application may boost its priority because it assumes nothing else will be running. "In a multiprocessing environment, that doesn't work," says Navas. The answer, he suggests, may be to offer a compatibility mode in which a particular ill-behaved application can run in a uniprocessor-emulation mode.

Navas's team, running AutoCAD, Windows applications, Ultimedia for OS/2, and other applications, has encountered no problems that he does not expect to see resolved by the time the code goes into beta. "Our only concern right now is how fast IBM is going to move forward," he says. "I've got people who are saying that they'd take it *yesterday*."

When we went to press, the decision on how to package OS/2 SMP had yet to be finalized. Weaving it into OS/2 2.2 is a possibility, as is offering it as a quiet upgrade—the way the Personal Systems Products division included the 32-bit graphics engine in its Service Pak late last year. IBM says it tentatively expects to sell it through the OEM channel on OS/2-equipped multiprocessing systems from IBM and other vendors.

However it hits the market, OS/2 SMP is sure to better IBM's attraction in the face of formidable opposition from Microsoft and from PSP itself. "One of the big objections I've seen many times, from clients who are looking at OS/2, is its lack of scalability," says Navas. "They're saying, 'It's limited to one Intel processor—what if I need more power than that?' This is the answer. It's limited to however many chips you want to buy, assuming the hardware guys come through and deliver reasonably priced systems." ■



In a symmetrical *multiprocessing system, the processors have equal access to system resources, and any processor can run any operating-system or application thread. In an asymmetrical system, one processor usually runs the operating system and controls access to resources, creating imbalances in the distribution of work across the processors in the system.*

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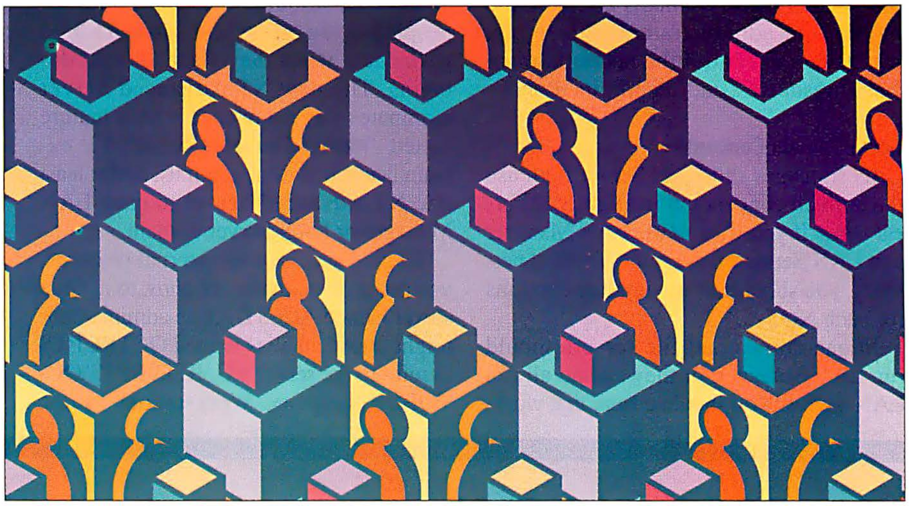
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OS/2 and Windows Networks

BARRY NANCE



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When you visit a foreign country, you use the local currency, and you try to follow the local customs. On many levels, you soon discover that people are not all that different. If you're familiar with Novell's NetWare, using a LAN based on OS/2 or Windows gives you the same feeling of being in a foreign country. You learn to think of the LAN in different terms, but you quickly find the net result—shared disk space, shared files, and shared printers—not all that different from what you're accustomed to. LANs based on OS/2 and Windows use different means to achieve file and print I/O redirection, and they offer some capabilities difficult to implement in a NetWare environment.

Two server-based NOSes (network operating systems), IBM's LAN Server 3.0 and Microsoft's LAN Manager 2.1, run on various flavors of OS/2 and share a common code base—programmers from IBM and Microsoft worked closely together to create the original versions of these products. Microsoft's newest operating system, Windows NT Advanced Server, runs on NT; Microsoft will continue to offer and support LAN Manager running on OS/2, as well as the NT Advanced Server.

Future products will use IBM's SMB protocols on NetBIOS to exchange file data. Lee Reiswig, president of IBM's Personal Systems Products Division, says his division plans to ship a peer-to-peer LAN product later this year or in early 1994. The as-yet-unnamed product has an object-oriented interface and a clipboard that lets different workstations share information. IBM licensed the core software from Symbotics. IBM will position its peer LAN relative to OS/2 the same way Microsoft does with Windows for Workgroups and Windows 3.1.

Other NOSes that work with Windows but aren't part of the base Windows environment include LANtastic for Windows, Invisible LAN, and WEB for Windows. Sun Microsystems says that later this year, it will release a version of NFS (Network File System) that will run on NT. IBM offers TCP/IP for OS/2. These latter two products help OS/2 and NT work with Unix-based servers.

LAN Server and LAN Manager

LAN Server 3.0 is a 32-bit NOS that the BYTE NSTL team has clocked as being faster than NetWare 3.11. LAN Manager uses many of the same commands as LAN Server and, like it, works internally. LAN Server runs on OS/2 2.x, which you buy separately, while LAN Manager comes bundled with OS/2 1.3.

> **IBM's LAN Server and Microsoft's LAN Manager have more similarities than differences**

LAN Server and LAN Manager are excellent environments for client/server computing. It's relatively easy to program an OS/2 computer, even one that is already running as a file server. If you have a staff of programmers or if the applications software you buy already supports LAN Server and LAN Manager, client/server architecture becomes a possibility. SQL Server, Oracle, and DB2/2 are examples of RDBMSes (relational database management systems) that work well on OS/2-based LANs.

In LAN Server and LAN Manager parlance, a *requester* is the software that lets a workstation log on to a domain—a group of file servers and workstations with similar security needs—and use network resources. Users have access to the network through the OS/2 LAN Requester program from OS/2 workstations and through the DOS LAN Requester program from DOS workstations. A server can share its files, printers, and even serial devices (e.g., modems) across the LAN. DOS requesters can't access a shared modem, but OS/2 requesters can.

During installation, the network administrator specifies a server to be a domain controller or an additional server. There is only one domain controller in a domain. You can set up several domains on a large LAN Manager or LAN Server network. On a small LAN, a file server can also act as a domain controller. Domains provide a simple way

to control access to the network and the network's resources. A network user can have accounts in multiple domains, but he or she can log on in only one domain at a time. Additional servers cannot be started, nor can users log on, if the domain controller is not running. Several domains can exist on the same LAN, each managed separately, but each file server belongs to only one domain. Domains are managed by network administrators who set up, maintain, and control the network, manage its resources, and support its users.

Same-Domain Concept

LAN Manager and LAN Server both use the domain concept but in slightly different ways. If you want to use LAN Manager and LAN Server on the same physical network, you should set up separate domains for each NOS.

In one domain, all file servers should run LAN Manager, or they should all run LAN Server. You should ensure that workstations in a LAN Server domain log on to a LAN Server domain before trying to access LAN Manager file servers. Workstations in a LAN Manager domain, however, can log on to any domain. Once logged on, you can access files on servers in other domains if the network administrator has given you access rights on the other servers and defined the other servers as external resources. In practice, most people just log off one domain and log on to the next when they want to cross domains. The new NT Advanced Server eliminates this annoyance with a feature called *Trusted Domains* (which I'll explain later); however, you must add at least one NT Advanced Server to each LAN Manager or LAN Server domain.

To give access to an external resource, you assign a nickname, or *alias*, to it. On a server named ACCTING, an administrator might create an alias named OCTRCPTS to refer to the server's C:\RECEIPTS\OCTOBER directory. Workstations equate the OCTRCPTS alias to a drive letter, perhaps drive G, to gain access to the files in that directory. The alias specifies the server where the directory is located and the path to the directory, so people at workstations don't have to remember server names and directory structures. An alias remains defined after the domain controller is stopped and restarted, but a network name does not.

LAN Server can use aliases for shared resources, but LAN Manager cannot. LAN Manager workstations must refer to the shared resources by their full name, not by the alias. Suppose you have a LAN Server machine named PRODUCTION that shares a printer with an alias of REPORTS. The full name of the shared printer is \\PRODUCTION\PRINTER1. LAN Server workstations can share REPORTS, but LAN Manager workstations must use the full name \\PRODUCTION\PRINTER1 to access that printer.

LAN Manager offers a feature called

NetBIOS and SMBs

The NOSes (network operating systems) discussed in the main text use NetBIOS to send and receive messages. The NetBIOS messages contain Server Message Blocks, or SMBs, to carry file I/O requests and responses between servers and workstations. NetBIOS accepts communications requests from the file redirection portion of the NOS or from an application program, such as an E-mail product. NetBIOS operations fall into four categories:

Name support—Each workstation on the network is identified by one or more names. These names are maintained by NetBIOS in a table; the first item in the table is automatically the unique, permanently assigned name of the network adapter. Optional user names (e.g., Barry) can be added to the table for the sake of convenient identification of each workstation. The user-assigned names can be unique or, in special cases, can refer to a group of users.

Session support—A point-to-point connection between two names (workstations) on the network can be opened, managed, and closed under NetBIOS control. One workstation begins by listening for a call; the other workstation calls the first. The computers are peers. Both can send and receive message data concurrently during the session. At the end, both workstations hang up on each other. LAN Server, LAN Manager, Windows for Workgroups, and NT Advanced Server establish sessions between workstations and servers.

Datagram support—Message data can be sent to a name, a group of names, or all names on the network. A point-to-point connection is not established, and there is no guarantee that the message data will be received.

Adapter/session status—Information about the local-network adapter card, other network adapter cards, and any currently active sessions is available to applications software that uses NetBIOS.

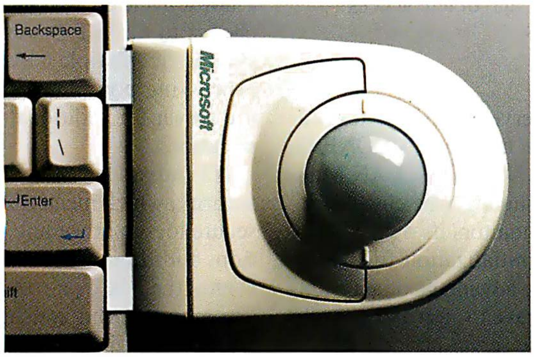
At the workstation, the requester software intercepts an application's file I/O operations and sends them across the network to the file server, using IBM's SMB protocol to accomplish the redirection. SMBs can be used for session control, file access, print service, and sending messages.

Session control—Once a NetBIOS session is established between a workstation and the server, the workstation sends a Verify Dialect SMB to the server. This message contains data indicating the capabilities of the version of the PC LAN Program running at the workstation. The server examines this message and responds to the workstation with information about itself and the capabilities the server supports. This exchange is then followed by one or more Start Connection SMBs, which are used to create logical connections between the workstation and network resources at the file server. These logical connections are later terminated by the workstation when it sends End Connection SMBs to the server (or when the NetBIOS session is aborted by the occurrence of an error).

File access—A workstation uses the SMBs in this category to gain access to the files on the server's hard drive. The functions included in this category let the workstation treat the server drive almost like a local hard drive—the workstation can create and remove directories; create, open, and close files; read, write to, rename, delete, and search for files; get or set file attributes; and, of course, lock records. The requester detects file operations intended for network files and converts the operation into one or more SMBs. The local operating system (e.g., DOS or OS/2) never sees file requests for network files. The server performs the file operation when it receives the SMB message and returns a response to the workstation's requester.

Print service—The SMBs in this category let a workstation queue files for printing by a server and to obtain print-queue status information. The workstation can create a spool file, write data to the spool file, close the spool file, and ask that the server return a print-queue status SMB.

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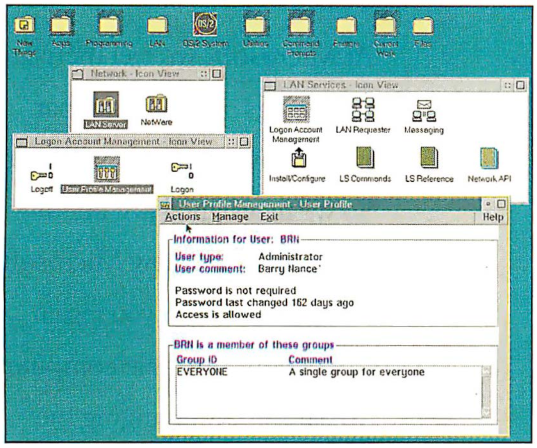
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IBM's OS/2 LAN Server.

persistent net connections that helps you avoid retyping resource names at log-on time. By default, each time you log on, you get the same network connections you had in your last session. You can enable or disable persistent connections with the /PERSISTENT= option on the NET USE command. You can also put entries in a user's LANMAN.INI file to turn persistent net connections on or off or to freeze a certain set of network resources as shared by that user.

An administrator assigns a network name to a resource (e.g., disk directory, printer, or serial device) to define the resource temporarily. Like an alias, a network name identifies a shared resource on a server. But to use a resource through its network name, you specify the server name as well as the network name. Unlike an alias, a network name does not remain defined if the domain controller is stopped.

A UNC (Universal Naming Convention) name consists of a server name and a network name, which together identify a resource in the domain. A UNC name has the following format:

```
\\servername\netname\path
```

Note the use of the double backslash characters preceding the server's name.

If you assign LPT1 to a shared print queue, you override your local printer port, and your print jobs go to the network printer. On the other hand, you can't override local drive letter assignments. If you have drive C on your computer, you must use other drive letters besides C to refer to file-server disk resources.

Security

User-level security on a LAN Manager or LAN Server network consists of log-on security and permissions. Each user account has a password; you specify your user ID and password to gain access to the network through a domain. A network administrator can limit a particular user's access to certain times of the day or the workstation(s) from which a user logs on. Permissions limit the extent to which you can use shared resources. The network administrator, for example, can create a COMMON directory that everyone can use, and the administrator can create an UPDATE directory, with files only certain people can modify but everyone can read. With share-level security, a feature of LAN Manager, the administrator can set up a single password to limit access to a particular shared resource or device. LAN Server does not support share-level security.

The network administrator creates an access-control profile to grant, restrict, or deny access to a shared resource. Each shared resource (usually a disk directory) can have just one access-control profile. An administrator can put individual log-on accounts in an access-control profile, or the administrator can set up named groups of accounts and insert group names in the access control profile. Group names are more convenient, and they help keep the profile to a manageable size. Each individual or group name has a list of permissions and security restrictions the administrator can use. The access permissions allow or disallow the following operations:

—run programs
—read and write data files
—create and delete subdirectories and files
—change file attributes
—create, change, and delete access control profiles

Fine Tuning

You tune LAN Server by using a text editor to modify the computer's CONFIG.SYS and IBMLAN.INI files. LAN Manager features auto-tuning, whereby the file-server software monitors its own activity and changes its initialization files automatically. To take advantage of auto-tuning, you merely have to stop and restart a LAN Manager file server periodically.

LAN Manager and LAN Server interoperate well on a Token Ring LAN but not on an Ethernet LAN. On Ethernet networks, you may need to modify both NOSes' configurations. LAN Server supports the DIX (Digital/Intel/Xerox) 2.0 protocol and the IEEE 802.3 protocol; LAN Manager does not support DIX. On Ethernet networks, you need to switch LAN Manager and LAN Server to use IEEE 802.3 so that workstations can use both file servers.

You should also note that the networking products from Microsoft and IBM can't do packet routing inside a file server, as NetWare can. You need to buy router hardware if you want to segment your LAN. Mike Nash, product manager at Microsoft, says that Microsoft and IBM share the philosophy that file servers aren't the place to do packet routing. On the other hand, if you decide to link two or more LANs, you have a wide variety of options to choose from. For example, you might connect LAN Server or LAN Manager through a leased line, T1 link, or X.25 connection.

Both LAN Server and LAN Manager support the use of RFS-compliant (Remote File System) NetBIOS over TCP/IP. Through appropriate routers or bridges, you can issue standard NET USE commands to gain access to remote shared resources.

Windows NT Advanced Server

In early August, Microsoft surprised the industry by releasing NT Advanced Server at the same time as NT itself. Microsoft had said that NT Advanced Server would lag behind NT by about 30 days. NT Advanced Server extends the features and advantages of LAN Manager in a number of ways.

Like LAN Server, NT Advanced Server is a 32-bit NOS; however, unlike with LAN Server, you can run NT Advanced Server on Intel, Mips R4000, or DEC Alpha platforms. While CPU speed is rarely a bottleneck on file servers, you might choose to run NT Advanced Server on a symmetric multiple CPU. The extra CPU processing power might let you use the file server for additional client/server applications.

NT Advanced Server offers C2-level security, which means that the NOS has a secure log-on procedure, memory protection, auditing, and discretionary access control (i.e., the owner of a shared resource can monitor who is using the shared resource). Some corporate and military LANs require C-2 or higher security. In the area of reliability, NT Advanced Server uses a transaction-based file system that can back out file updates if a series of related updates don't finish successfully. NT

Advanced Server supports RAID level 5 (disk striping with parity), recognizes signals from a UPS (uninterruptible power supply), and comes with tape-backup software.

Trusted Domains

NT Advanced Server adds Trusted Domains to the way domains work in LAN Server and LAN Manager. Suppose, for instance, that your LAN has separate domains for engineering and marketing. People in the engineering department have developed a new product and want to let product managers in the marketing department see the specifications for the new product. The engineering department can authorize access to its files by making the marketing domain *trusted* and giving read-only permissions to the product manager's group. The product manager doesn't have to separately log in to the engineering domain to view the files. When the file server holding the documents senses a request from a marketing-domain product manager, the file server verifies access permission, with the trusted marketing-domain controller, through the engineering domain controller.

A Performance Monitor utility helps administrators manage NT Advanced Server, and the NOS is also SNMP- and NetView-aware. Desktop and LAN management products such as OpenView, LANLord, LANDesk, and Frye's Utilities should soon support NT Advanced Server. Microsoft says NT Advanced Server will comply with the DMTF (Desktop Management Task Force) specification for the management of LAN-connected desktop computers as soon as the DMTF finalizes its specification. Other utilities you get with Advanced Server include User Manager, Disk Administrator, Event Viewer, and an enhanced Control Panel.

If you prefer not to establish permanent drive-letter mappings for each workstation but rather to let each workstation browse lists of shared resources to create new connections to shared directories and printers, you'll like NT Advanced Server's BrowseMaster feature. Each PC with resources to share periodically reports a list of those resources to the BrowseMaster server. When a person at a workstation clicks on the Browse push button (e.g., in Windows for Workgroups File Manager or Print Manager), the workstation gets the list of available resources from the central BrowseMaster computer. This technique keeps LAN traffic down, because servers and workstations don't have to continually broadcast resource lists to each other.

NT Advanced Server uses SMBs, on NetBIOS, to send and receive file I/O redirection requests over the LAN cable. This means that NT Advanced Server should interoperate with LAN Server, LAN Manager, Windows for Workgroups, and even the older PCLP (PC LAN Program). In addition, NT Advanced Server supports TCP/IP and Novell's IPX/SPX transport-layer protocols.

> **Native Networking Options**
>
> **Windows**
> **Windows for Workgroups**
> **Windows NT**
> **Windows NT Advanced Server**
>
> **OS/2**
> **LAN Server**
> **LAN Manager**
> **NetWare 4.0 for OS/2**

You get a wealth of other connectivity options with Microsoft's latest NOS: Windows Sockets, Named Pipes, NetDDE, IBM's DLC (data-link control) for host sessions, and RPCs (remote procedure calls). This last interface is compatible with the OSF/DCE (Open Software Foundation/Distributed Computing Environment) specification. Microsoft says it will offer connectivity modules for SQL Server and SNA Server. The version of Remote Access Server for NT Advanced Server handles up to 64 concurrent connections over dial-up, leased, X.25, and ISDN lines. And NT Advanced Server has Macintosh support built in.

Windows for Workgroups

Windows for Workgroups is a marriage of Windows 3.1 and NOS that includes an E-mail application (i.e., Microsoft Mail) and an appointment book application (i.e., Schedule+). The two software products install themselves into the main program group.

If you're a part of a small team of people who are accustomed to using applications in a Windows 386 enhanced-mode environment, Windows for Workgroups can help you share information. Shared files can exist on every PC running Windows for Workgroups in 386 enhanced mode, or they might be located on a separate, unattended PC that you use just for file storage. A PC must be running Windows for Workgroups in 386 enhanced mode to share files, however.

Users who use Windows for Workgroups can share printers as well as disk files. Using File Manager and Print Manager, you can designate the PCs that should share disk directories and those that should share printers. When you share a disk directory or printer from a PC, you give the shared resource a name by which other users can refer to that resource.

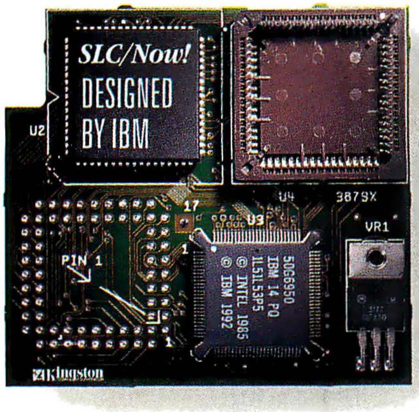
Other users establish connections to shared resources by also using File Manager and Print Manager. Establishing the connection assigns a new drive letter (perhaps D) to a shared directory and, for a shared printer, redirects the parallel printer port (LPT1) across the LAN to the shared printer. You can tell Windows for Workgroups to remember the connections you've established. Windows for Workgroups will automatically re-create each connection when you start Windows. You have access to shared directories and printers both from within Windows and from within the DOS applications you run in a Windows DOS session (either via the DOS Prompt icon or a program information file, or PIF).

You can use Windows for Workgroups to add convenient peer-to-peer networking functions on a LAN that is running LAN Manager, LAN Server, or NT Advanced Server. Security on a Windows for Workgroups LAN isn't great, but for small groups who already use Windows, this entry-level peer-LAN environment can be effective. Windows for Workgroups is the easiest LAN to set up and use.

Building a LAN based on Windows or OS/2 can be a good investment. You'll find these environments fertile ground for client/server applications. For example, you can save hardware and software dollars by running a database manager directly on the file server. You'll be able to easily create peer-LAN relationships on a Windows or OS/2 LAN. Or you might use one of these NOSes as an application server on a LAN that's already running Novell NetWare.

Novell has about 70 percent of the NOS marketplace, and that percentage isn't likely to plummet significantly any time soon. However, you may find it advantageous to add LAN Server, NT Advanced Server, or perhaps Windows for Workgroups to your Token Ring or Ethernet LAN. At first, the new NOS may make you think you're in a foreign country. But you'll find the extra drive letters and other shared resources not all that different from NetWare's. And you may find you spend less money on network software. ■

Barry Nance, a programmer for the past 20 years, is a BYTE contributing editor. You can reach him on BIX as "barryn."

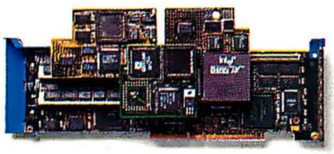




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SLC/Now!	PS/2 Model 50	With SLC/Now! 50	PS/2 Model 90-0H9	SLC/Now!
Landmark Speed 2.0: Recount: Retail Price:	13 MHz 3:34 Min.	114 MHz :29 Sec. $425	84 MHz :38 Sec. $3,280	IBM PS/2 Models 50, 50Z and 60
486/Now!	PS/2 Model 70-25MHz	With 486/Now! SX 25	PS/2 Model 90-0H9	486/Now!
Landmark Speed 2.0: Recount: Retail Price:	39 MHz :55 Sec.	84 MHz :39 Sec. $495	84 MHz :38 Sec. $3,280	IBM PS/2 Models 70 and 80, Compaq Deskpro Models 386/16, 386/20, 386/20e, 386/25, 386/25e, 386/33
MCMaster	PS/2 Model 55SX	With MCMaster SX 25	PS/2 Model 90-0H9	MCMaster
Landmark Speed 2.0: Recount: Retail Price:	16 MHz 2:47 Min.	84 MHz :36 Sec. $795	84 MHz :38 Sec. $3,280	IBM PS/2 Models 55, 56, 57, 65, 70, 80 and 90

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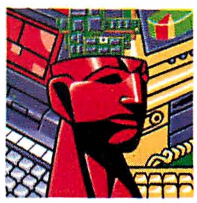
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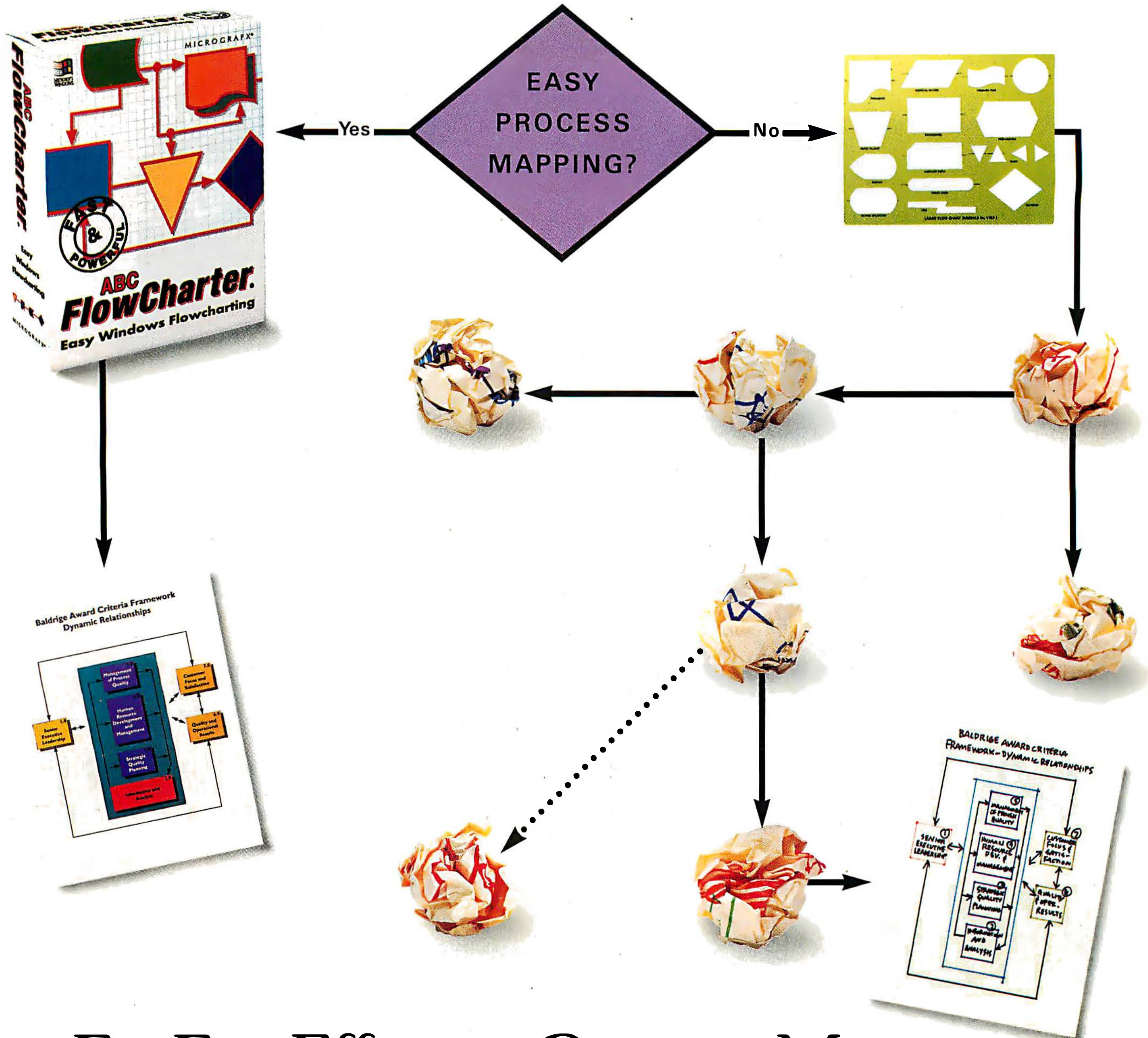
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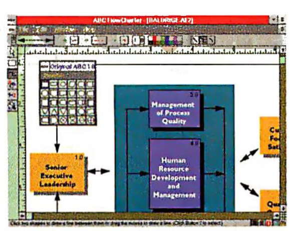
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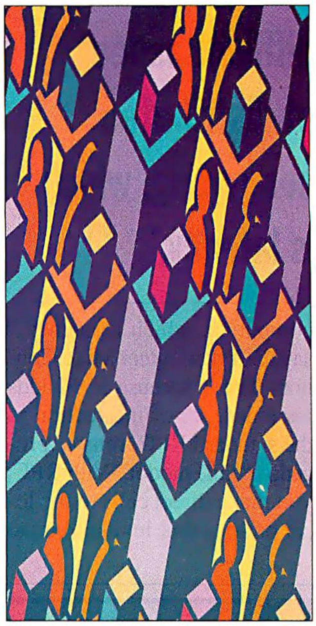
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IBM's Assault on Distributed Objects

With its Distributed System Object Model, IBM is in the forefront of bringing the benefits of object technology to distributed applications

JON UDELL



Networking

When IBM shipped OS/2 2.0 in the spring of 1992, the company touted the new object-oriented Workplace Shell as a major achievement. While the WPS itself garnered mixed reviews, the foundation on which it rests—the System Object Model—emerged as an object technology to be reckoned with. Its successor, the Distributed System Object Model, extends objects across networks and forms the cornerstone of IBM's distributed-object strategy.

SOM 1.0, which shipped with OS/2 2.0 and 2.1, is an operating-system extension that provides OOP (object-oriented programming) mechanisms such as inheritance and method dispatching. OOP-language products such as Smalltalk and C++, which have traditionally provided these mechanisms, can't adequately package objects for binary reuse across languages or even across implementations of the same language. The SOM 2.0 engines (there are two) retain backward compatibility with the 1.0 version while adding multiple inheritance, C++ bindings, and an interface-definition language that can now work in combination with the latest Object Management Group standard. Both engines—the Workstation Runtime and the Workgroup Runtime—are available as part of the SOMobjects Developer Toolkit.

Objects Local and Remote

The Workstation Runtime engine enables objects to communicate across process boundaries on a single OS/2 or AIX system. The Workgroup Runtime engine enables those same objects to communicate across system boundaries over NetBIOS, TCP/IP, or IPX transports. This engine swaps byte order as needed to keep data streams intelligible in mixed networks of OS/2 (Intel) and AIX (RISC) machines. There's no protocol bridge yet, however, so stations on LAN Server networks will have to run NetBIOS and TCP/IP concurrently to talk to stations on AIX networks.

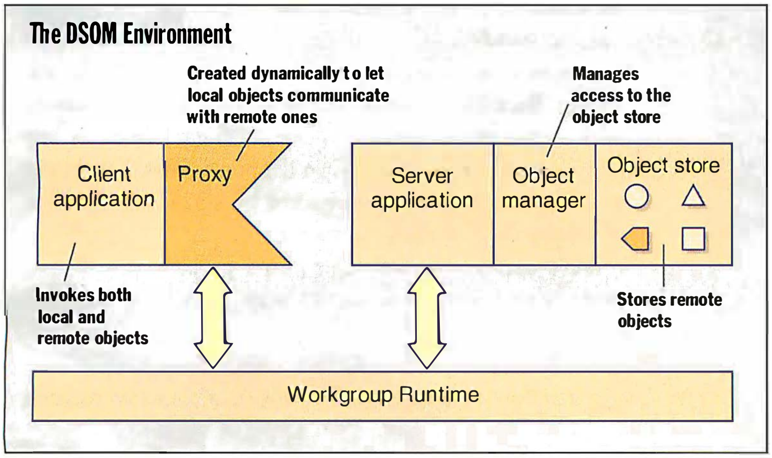
The Workstation Runtime will help correct a flaw in the WPS. Currently, user-written shell objects share address space with the WPS itself and can therefore crash it. With SOM 2.0, such objects can optionally run in a separate address space. The WPS in OS/2 2.1 can't take advantage of this feature yet, but a future version will be able to. More important, the Workstation Runtime will enable developers to build on a single machine the distributed-object systems they plan to deploy on networks. To switch from single- to multiple-machine mode, you just replace the Workstation Runtime ($75) with the Workgroup Runtime ($235).

Object Framework

In addition to the run-time systems, the SOMobjects Developer Toolkit ($365 for OS/2; $585 for AIX) includes the SOM compiler, documentation, a class that supports collections (notable because it's the first IBM product derived from the Taligent effort), and three sets of C++ classes that IBM calls *frameworks*.

The emitter framework provides IDL (interface definition language) parsing support for those interested in binding SOM to a programming language other than C or C++. MicroFocus used this framework to bind SOM to its COBOL implementation. The persistence framework writes objects out to disk and reads them back. The replication framework has a number of intriguing uses: Objects that inherit from it can share common data safely. A collaborative text editor, for example, might use the replication framework to enable live editing of a document by multiple concurrent users.

"DSOM gives you the opportunity to solve the most difficult aspect of distributed



The DSOM Environment lets applications take advantage of remote objects by creating a local proxy that regulates access to remote methods.

> **"DSOM gives you the opportunity to solve the most difficult aspect of distributed computing, which is latency."**

computing, which is latency," says SOM architect Mike Connors. That's because SOM adds another layer of indirection to the standard RPC (remote procedure call) model. With RPC, you make direct calls to the local proxies that invoke remote procedures. With DSOM, even calls to local proxies are dispatched through method tables. If you write an intelligent proxy, Connors says, you can cache some object-state information locally. That way, you won't automatically incur network delay every time you inquire about a remote object's attributes.

You won't go out and buy DSOM directly. Instead, you'll acquire it from developers of DSOM-based applications and utilities. One early proponent is ChipChat-Cawthon Software, a longtime developer of OS/2 communications software. The company's ChipChat SOM objects support file transfer and terminal emulation over serial, parallel, and telnet ports. "If we didn't already give you telnet support," says ChipChat-Cawthon's president Marty Cawthon, "you could add it yourself in the language of your choice and automatically inherit our ability to perform XMODEM, YMODEM, Kermit, and ASCII file transfers. Our ChipChat object encapsulates communications ports at a high level, just as a UART encapsulates them at a lower level."

The Wide World

IBM's DSOM strategy doesn't end with OS/2 and AIX. Windows support is due by year's end, according to IBM's object czar Cliff Reeves. Moreover, a technology exchange with Hewlett-Packard will synchronize DSOM with HP's Distributed Object Management Facility. For HP, the deal means access to DSOM, a finer-grained object technology than HP's own. For IBM, it means a strategic link between DSOM and DCE (Distributed Computing Environment). While DSOM offers its own native directory service, IBM is investing heavily in DCE for large-scale distributed systems. The ability to run DSOM over DCE will be crucial. DSOM will also provide the packaging and method-dispatching services used by Apple's forthcoming distributed compound-document technology, OpenDoc.

Distributed computing will have truly arrived when software developers can build distributed objects the same way they write stand-alone ones. If IBM delivers the SOMobjects Developer Toolkit for Windows by year's end as promised, DSOM, rather than a future version of OLE, could be the first to realize that dream. ■

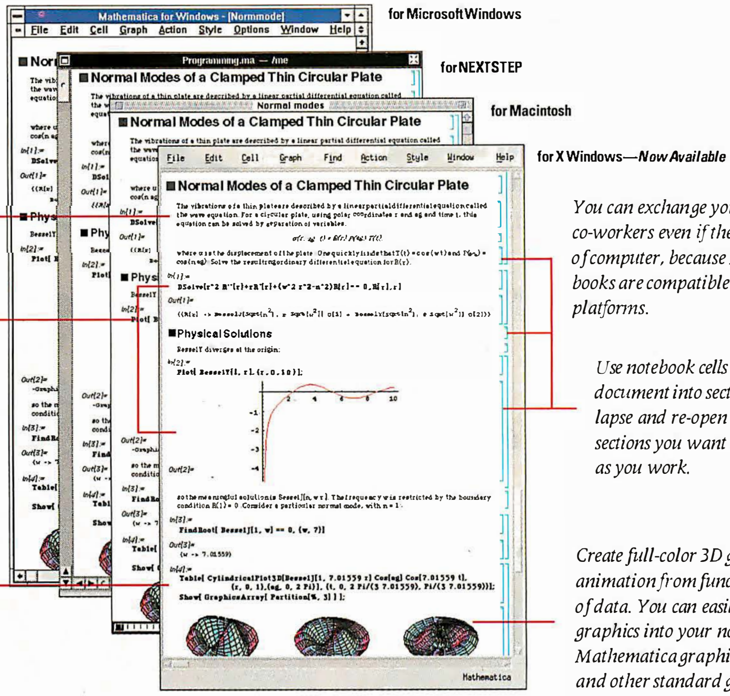
Jon Udell is a BYTE senior technical editor at large. You can reach him on BIX as "judell" or on the Internet at judell@bytepb.byte.com.

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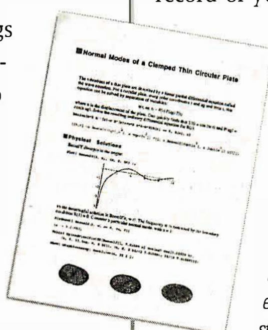
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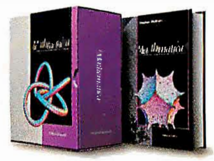


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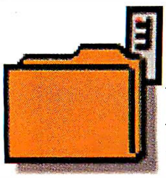
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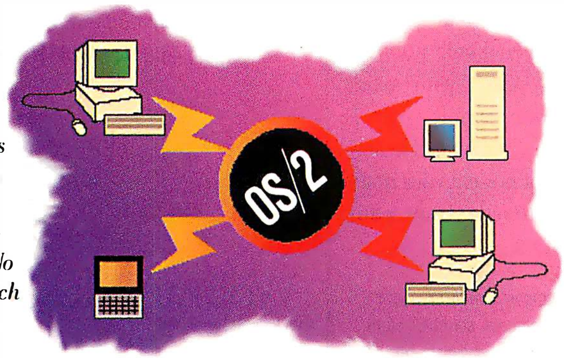


accessing your mainframes, minis and PCs when necessary and bringing their power and capacity to the desktop level. **Fact:** the Windows NT™ solution is based on PC servers and desktops and *doesn't* embrace all your existing resources. That could mean porting applications and data. The only plus that offers is the cost of porting *plus* the cost of additional PC servers.

Fact: OS/2 2.1 runs DOS, Windows™ and more than 1,200 native OS/2 applications. With LAN Server 3.0 or Novell® NetWare,® OS/2 supports DOS, Windows, OS/2 and Mac clients. **Fact:** it's not likely NT will support all your existing applications. It won't run existing 32-bit applications like WordPerfect® 5.2 for OS/2 and Lotus® 1-2-3® for OS/2. It *will* require additional software to support DOS, OS/2 and even Windows clients. Worse yet, *Infoworld* sources report that Windows 3.x applications run *20% slower* under NT than they do under OS/2 2.1!



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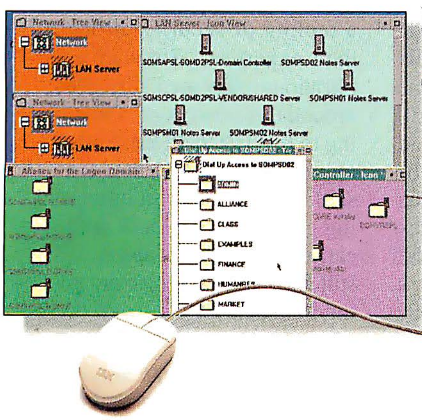
Domain/DACS,™ AlertView,™ Foundation Manager™), and more. **Fact:** The NT strategy is still Not There, and neither are native client/server applications.

Fact: OS/2 is committed to the industry-accepted Distributed Computing Environment (DCE) standards of the Open Software Foundation. **Fact:** NT is NoT.

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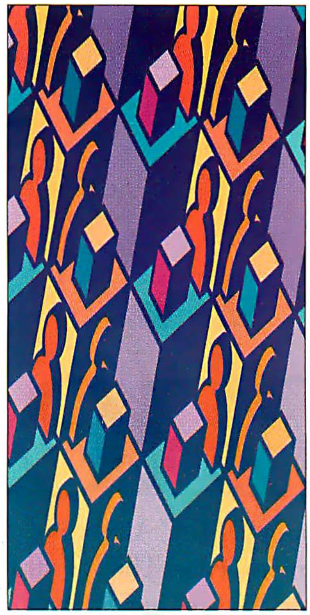
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Developers Cautiously Optimistic About Multiplatform OpenDoc

Are users ready to have documents—as opposed to applications—become the focus of desktop computing?

DAVE ANDREWS



Networking

One of the benefits of Microsoft's OLE 2.0 technology is that it lets you focus on the document you're creating instead of the Windows applications that created it. OLE 2.0's integrating features, such as its support for in-place editing and drag-and-drop of data, show promise for interapplication collaboration on a single CPU. But OLE 2.0 does not address remote execution of applications and sharing of data among Mac, Windows, Unix, and OS/2 applications running over a network.

Currently, only programmers developing Windows applications can take advantage of OLE 2.0. Microsoft says it will release implementations for Mac and Windows NT developers by year's end, but this still leaves OS/2 and Unix out of the picture. Several companies, uncomfortable with OLE 2.0's lack of support for other operating systems and its control by a single company, have announced an architecture called OpenDoc that promises an object-based framework for developing applications that interoperate across platforms and distributed networks.

What's Inside

OpenDoc will use technology from several companies, including IBM's System Object Manager for its object-calling mechanism, Apple's Bento standard as its storage mechanism, and the industry-standard CORBA (Common Object Request Broker Architecture) for sharing objects across a network, according to Cliff Reeves, program director of object-oriented technology products for IBM's Personal Systems Products division. WordPerfect is working on an implementation of OpenDoc for Windows (WordPerfect's OpenDoc effort was code-named *Amber*) that will interoperate with OLE 2.0, Reeves said. He added that an OpenDoc consortium, which will set the architecture's direction and certify applications for compliance, will be modeled after the X Consortium.

Reaction from third-party software developers to OpenDoc is mixed, partly because programmers are not expected to receive the first code drops for developing OpenDoc applications until late 1993. Hilmi Ozguc, senior product manager for Lotus 1-2-3, said the ideas espoused in OpenDoc fit well with Lotus's cross-platform orientation. "We like the direction ... but it's too early to come out and make a commitment." Also, because different parts of OpenDoc will come from different companies, developers questioned whether the three major companies providing OpenDoc technology—IBM, WordPerfect, and Apple—could successfully coordinate their efforts.

The Redmond Tack

Microsoft is working on its own distributed OLE solution, naturally. David Seres, Microsoft's OLE 2.0 product manager, said a distributed OLE implementation will be included with Cairo, Microsoft's unreleased, object-oriented version of Windows. But that isn't expected to ship until sometime in 1995.

Perhaps the biggest hurdle OpenDoc and Microsoft's distributed OLE will face at the end-user level is the network bandwidth issue. Network administrators may see a significant network performance degradation as applications access data or remotely execute other applications over the network. Others question if users and developers will truly accept the notion of small object programs, or *componentware*, exchanging data with other programs.

Craig Yappert, product marketing manager at Frame Technology, said one of the reasons users like working with a single application is that it gives them a feeling of security through their expertise. "Software applications really aren't designed around this concept of 'I'm going to be kind to all these other applications around me,'" he said. "OpenDoc is an interesting goal, but for a lot of applications and a lot of users, it's still unclear how people are going to use it." ■

Planned OpenDoc Features

- **Open scripting architecture**
- **Bento storage format defines how complex data is stored on disk in such a way that the producer of one document can exchange that concept with another producer rather than rely on private data forms**
- **Technology road map set by multivendor consortium**
- **Support for Unix, Windows, Mac, and OS/2**
- **Support for irregular document frames, version control, in-place editing**

Dave Andrews is a BYTE news editor. You can reach him on the Internet at dave.news@bix.com.

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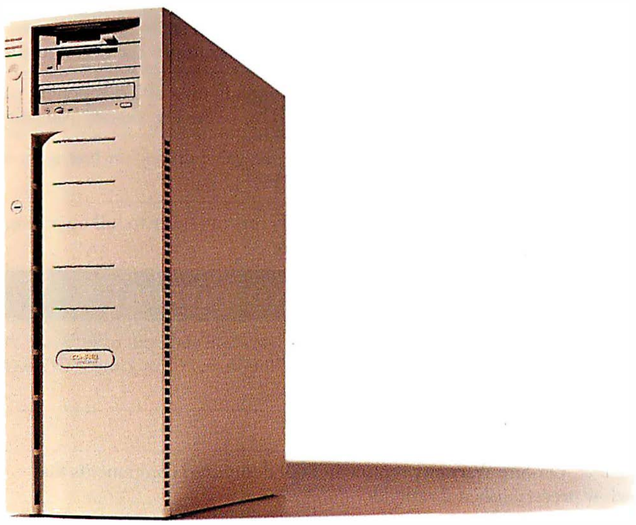


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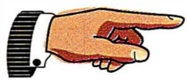


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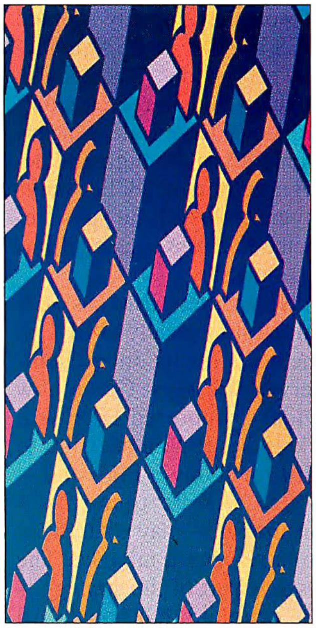
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IBM Ships DCE SDK for OS/2 and Windows



Big Blue makes DCE the cornerstone of its future distributed-computing platforms. Will DCE carry the load or sink under its own weight?

ANDY REINHARDT

Networking

Given a reputation for lagging the market in software, IBM's recent announcement of the first Distributed Computing Environment SDK (Software Development Kit) for OS/2 and Windows is especially noteworthy. As one of the founding members of the OSF (Open Software Foundation), which distributes DCE, IBM has long played a major role in that organization. However, IBM's true commitment to open systems continued to be questioned by some observers.

Now, IBM has shipped a set of tools that facilitates the creation of distributed applications across not just IBM platforms (i.e., OS/2 and AIX), but also non-IBM Unix servers from competitors such as DEC and Hewlett-Packard. By embracing DCE as a strategic direction, IBM has confirmed that SAA (Systems Application Architecture) is no longer its only play. And with client support for Microsoft Windows, IBM shows that it is increasingly more practical than parochial.

Inside DCE

DCE is an architecture for multiplatform distributed computing defined by the OSF. It's based on contributions from member companies and MIT. DCE encompasses a mechanism for RPCs (remote procedure calls), security and authentication based on MIT's Kerberos, a timing service that synchronizes clocks throughout a network, a "cell" naming and directory service, and a threads service, which adds multiple program threads to Unix. The SDK will let developers write applications for OS/2 and Windows clients that will meet the DCE specification and can call services on DCE-compliant remote servers. OS/2 server support is slated for later delivery.

IBM also has committed to supporting DCE throughout its product line. Client and server compliance already is available for AIX and is planned for OS/400 and MVS. When implemented, this scheme should allow complete interoperability among IBM systems and systems from its competitors. "DCE is fundamental to IBM's whole approach to client/server and distributed computing," says John Rymer, editor of *Distributed Computing Monitor*, "to the point where they're almost too obsessed with it for their own good."

The reason for Rymer's observation is that DCE isn't the only game in town, and its acceptance has been slow, to say the least. After dribbling out of OSF in 1991, the technology has spent the last two years being evaluated by corporate and commercial users in feasibility and pilot programs, but it has not exactly taken the market by storm. In part, this was due to its heavy association with Unix, but this is changing now that implementations of DCE for non-Unix platforms are starting to appear.

Beyond Unix

One such program, and the source of IBM's Windows DCE offering, comes from Gradient Technologies (Marlborough, MA), whose PC/DCE is an implementation of DCE client-side support for DOS/Windows 3.1. Gradient did not implement DCE server-side support because it requires a robust, preemptive multitasking foundation, which DOS couldn't provide. However, the company will likely create DLLs for Windows NT that implement both the client and server modes of DCE. This third-party solution will let NT systems interoperate with Unix servers and IBM minicomputers and mainframes.

That Gradient couldn't practically implement DCE server capabilities on DOS/Windows points to DCE's main impediment to widespread adoption: It was designed presuming an all-Unix world of desktops and servers. Notes Rymer, "A lot of people I talk to see DCE as almost irrelevant; it's too big, too complex. The dominant desktop now is Windows, but DCE's design point was a much more powerful client."

IBM's response to this problem, naturally, is to emphasize OS/2 as a client, because it is a fully 32-bit, preemptively multitasking, multithreaded operating system. Another alternative is to forgo DCE entirely and use NetWare to implement client/server applications.

"Look at what NetWare has become: a distributed-computing environment," says Rymer. Most client/server applications now under development are small in scale and designed for local workgroups, not worldwide enterprises, he argues. The high-end features of DCE are overkill for these users, while NetWare, he says, "has distributed directories, security, network management, but is optimized for the low end, for workgroups and LANs of PCs."

Another potential weakness of DCE is its security model, which is based on Kerberos, derived from the DES. Rymer

notes that many IBM competitors, notably Novell and Microsoft, have openly scorned DES in favor of RSA public-key encryption. "There's also concern that Kerberos won't work on a large scale, which is ironic given the high-end design center of DCE,'' says Rymer. Novell, he says, rejected Kerberos because it was too slow.

Nevertheless, IBM has committed strategically to DCE as the basis for its open client/server offerings. Given how widely supported DCE will likely be, IBM's decision to aim for today's high end—which will be tomorrow's mainstream—may not turn out to have been a mistake. The riskiest part of the strategy is the problem that haunts all open-system providers: If the products are truly interchangeable, how do you keep your customers from bolting to the competition? Here, IBM aims to win based on better service and support, market-leading implementations of standards-based technology (e.g., AIX), and superior network and enterprise management tools (e.g., NetView).

Scoping the Competition

The ultimate wild cards will be Novell and Microsoft. Both companies want to move into IBM's enterprise computing space by extending their current offerings upward, but neither one—to the chagrin of the OSF—has licensed DCE. Both companies support SNA (Systems Network Architecture) connectivity from their network servers, but this is mere plumbing compared to the high-level distributed-computing model encompassed in DCE.

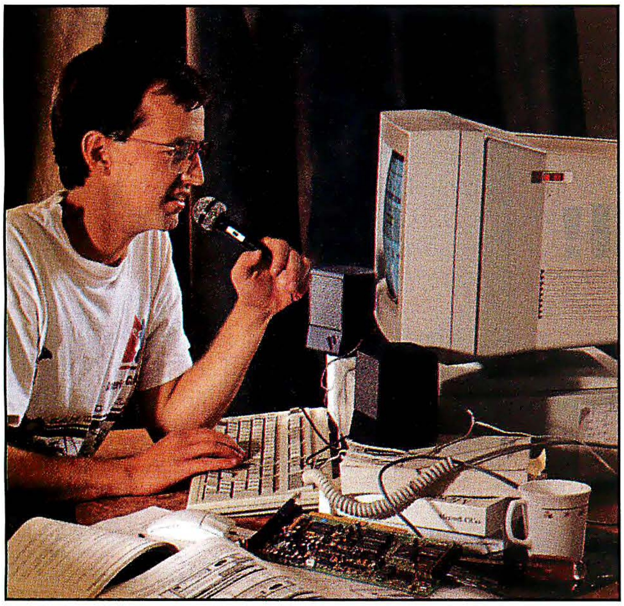
Novell is moving surprisingly slowly on DCE, given its acquisition of USL, which had committed to DCE, and the fact that it controls Unix. Novell has a lot of interest in preserving its own naming conventions, RPC methods, and security provisions, so the approach it probably will take will be to support DCE as a backbone mechanism for connecting NetWare LANs to each other or to DCE-compliant minicomputers and mainframes.

Microsoft's approach is, typically, even more proprietary and homegrown: The company has coded its own versions of some parts of DCE, such as a compliant RPC mechanism in LAN Manager and Cairo. But Microsoft isn't using the DCE cell directory (derived from Banyan technology), nor the X.500-based global directory services. And, of course, both companies have opted to use RSA encryption.

IBM's DCE SDK is shipping now (the Windows *client* still is in beta testing) and costs $1095, including five OS/2 and five Windows run-time licenses. Additional OS/2 client run-time licenses are available for $55. Although DCE is protocol-independent, this first implementation for OS/2 assumes TCP/IP, says Trudy Henke, IBM brand manager for OS/2 DCE. The OS/2 SDK implements all major DCE functions, but because OS/2 supports threads, the native mechanism is used. IBM's AIX client and server are one generation more advanced, and now they support distributed file systems and global directory services based on the X.500 model. ■

Andy Reinhardt is BYTE's West Coast bureau chief. You can reach him on BIX as "areinhardt."

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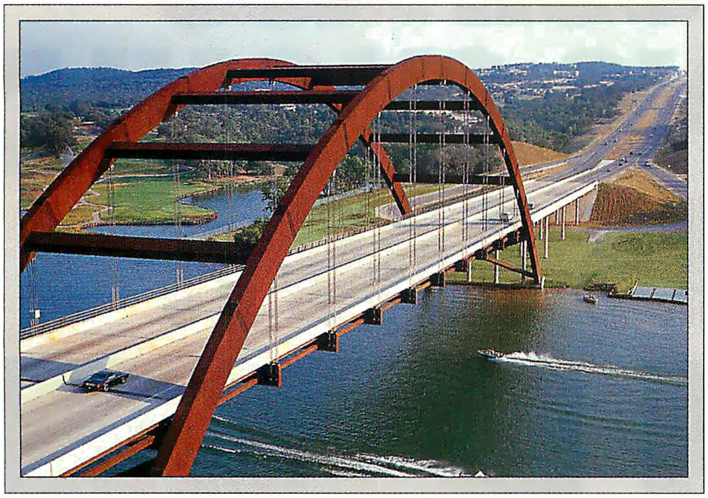
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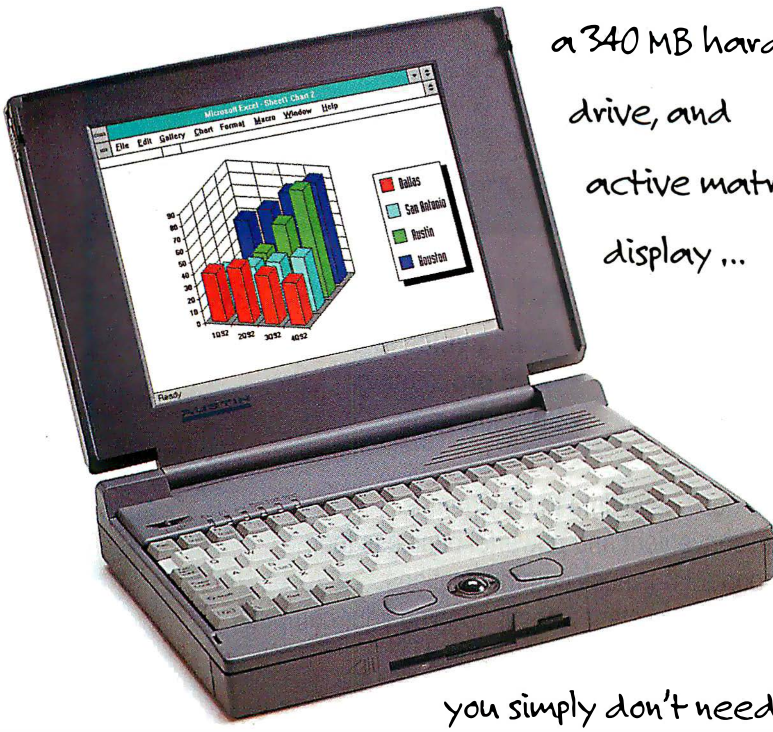
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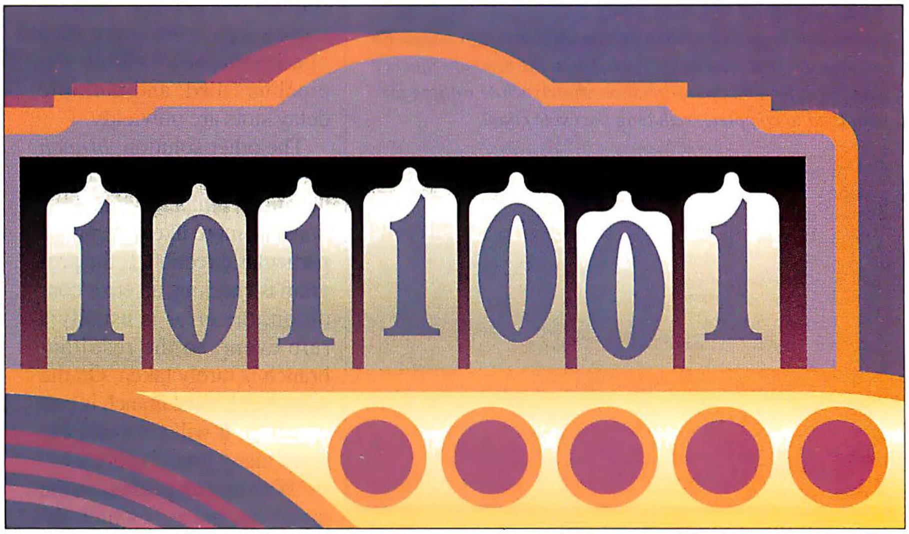
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Compilers: Essential Partners

OLIVER SHARP



DANIEL PELAVIN © 1993

Both Windows NT and OS/2 are portable; they run on multiple hardware platforms. Thus, they can take advantage of the latest generation of high-performance processors to bring unparalleled computing power to DOS and Windows users.

However, a high-performance processor such as the DEC Alpha or the PowerPC is only one part of a high-performance platform. An equal partner is the compiler used to generate code for the processor. Increasingly, Windows NT and OS/2 depend on advanced compiler technology to wring the utmost performance from the hardware.

During the last five years, a new generation of microprocessors has swept the industry. Today's processors use a variety of architectural advances that result in dramatically improved performance, but these improvements have introduced a lot of complications into the lives of programmers. It is now much more difficult to predict how long a particular sequence of instructions will take to execute. That uncertainty makes programmers even less willing to optimize code sequences by hand, leaving it up to the compiler to squeeze the best performance out of the system. Compiler writers have been working hard to live up to their new responsibilities.

Although there have been many changes in chip design during the last decade, compiler designers are only interested in the ones that have a visible effect on program execution. To a compiler writer, the most important parts of a processor are the pipelines, the cache, the registers, and the multiple functional units. The table on page 136 summarizes the characteristics of many of today's leading processor designs.

Air in the Pipes

Pipelining is an old idea for speeding up computation. In fact, it has uses far beyond computing. For example, an assembly line in a factory is just a pipeline for building widgets. As VLSI technology improves, chip designers are able to pack many millions of transistors onto a single chip; they have taken advantage of this freedom to pipeline the most important pieces of the processor, including instruction interpretation and arithmetic computations.

Pipelines work most efficiently when instructions flow smoothly through them. As each stage finishes working on one instruction, it must be able to start working on the next instruction as soon as possible. But in an unpredictable environment, a designer can't always prevent interruptions.

The processors behind today's sophisticated operating systems can't go very fast without an essential piece of software—the compiler

A load instruction, for example, imposes a delay while it accesses the cache. If the data is available, the processor will receive it within a small number of instruction cycles (typically one or two). During this *load shadow*, the processor may have to wait until the data arrives, introducing a gap (or *bubble*) in the flow through the pipeline.

Modern chips try to do some useful work in the shadow. The easiest way is to "expose" the load delay—the architecture of the chip specifies that the instruction following a load (in what is called the *load delay slot*) may not use the value being loaded. Because it isn't dependent on the results of the load, the instruction in the slot can execute while the load is still pending.

A compiler for an architecture that uses an exposed delay slot can rely on a variety of strategies to find suitable instructions. In a simple strategy, the compiler generates naive code and then goes back and shuffles the order around a bit to fill as many delay slots as possible. If the compiler can't ferret out an instruction to put in the delay slot, it is forced to put a NOP (no operation) there. Because of

the complexities that load delay slots create for superscalar instruction issue, most present-day processors have abandoned this feature.

The second way to fill the load shadow puts the burden on the processor. After a load is issued, the chip continues to the next instruction and tries to execute it. If the new instruction uses the data being loaded, the chip prevents execution from continuing via an *interlock*. The compiler is free to blithely output instructions without paying any attention to delays. It will produce better code, however, if it factors in the delay while choosing an instruction order. Note that an exposed delay slot and a hidden one require the same analysis to exploit; an exposed delay just forces the compiler to be honest when it fails to find a useful instruction to put in the shadow (see the listing above).

Rearranging for the load delay. *This listing shows two instruction sequences that compute the same expression. By moving the first load instruction down, the second sequence can begin the add operation immediately while waiting for that load to complete, reducing the cycle count.*

```
expression: x = a + (b + c)
code:              cycle of issue:
r1 = a                  1
r2 = b                  3
r3 = c                  5
r4 = r2 + r3            7
r5 = r1 + r4           10
   finish after        12
code:              cycle of issue:
r2 = b                  1
r3 = c                  3
r1 = a                  5
r4 = r2 + r3            6
r5 = r1 + r4            9
    finish after       11
```

The Problem with Branches

More troublesome than load shadows are branch instructions. Unconditional branches aren't a problem, because the processor can tell which instruction will be executed next and prefetches it. However, you can get a break in the smooth flow of instructions through the pipeline when the processor encounters a conditional branch. The condition that determines which way the branch will go may not be determined when the processor encounters the instruction, leaving the processor with no idea whether it should prefetch normally or assume that the branch will be taken. The processor must halt prefetching until it can tell which direction the branch goes in. This introduces idle processor time, which is a performance penalty.

To reduce the performance cost of branches, processor designers have come up with two strategies. The first is to expose the delay, creating a branch delay slot. The instruction following a conditional branch statement is always executed, regardless of whether the branch is taken. With the advent of superscalar processors, however, delay slots have become less popular, because these chips need more than one instruction to keep the pipeline filled, and multiple delay slots are unwieldy.

The other solution, *branch prediction*, is based on the fact that, in general, branch instructions are more likely to go in a particular direction. If the program is checking an error condition, the error is usually a rare event, so the resultant branch is rarely taken. On the other hand, if the branch is part of a loop, it will normally execute many times before it exits. With branch prediction, the processor guesses which direction the branch will go in and begins executing the likely branch ahead of time. If the guess is wrong, the work must be undone. The cost of a mistaken guess depends on the pipeline complexity and ranges from a single cycle to as many as 10.

But how does the processor determine whether a branch will be taken? One way is to look ahead; since a modern chip prefetches several instructions at a time, it may be able to figure out the outcome of a branch far enough in advance to begin fetching the appropriate follow-on instructions. The compiler can help by putting a few instructions between the evaluation of the test expression and the branch.

When all else fails, somebody or something must guess which way the branch will go. The processor can force the compiler to do it by having the compiler put a hint in the branch instruction. To compute the hint, the compiler can analyze the code, use profiling information, or both. Alternatively, the chip can make its own guess. The two usual techniques are *static prediction*, in which the chip guesses based on whether the jump is forward or backward, and *dynamic prediction*, in which the chip caches the most recent branches and assumes that cached branches will behave the same way they did the last time. The PowerPC uses static prediction with an optional overriding, compiler-specified hint in the branch instruction, while the Pentium relies on dynamic prediction.

Another way a compiler can reduce the cost of branches is to get rid of them. Three major ways to cut down on the number of branches are to evaluate them at compile time, move them out of loops, or execute

CHIP COMPARISON CHART

CHIP	# REGISTERS	EXPOSED DELAY SLOT	BRANCH PREDICTION[1]	FUNCTIONAL UNITS[2]	WORD SIZE
Alpha 21064 (DEC)	32 GPR[3] 32 FPR[4]	No	Hint	1 integer 1 floating-point 1 load/store 1 branch	64
R4x00 (Mips)	32 GPR 32 FPR	Branch	None	1 integer 1 floating-point	64
PowerPC 601 (IBM/Motorola)	32 GPR 32 FPR	No	Static with hint override	1 integer 1 floating-point 1 branch	32
Pentium (Intel)	8 GPR, FP stack	No	Dynamic	2 integer 1 floating-point[5]	32

[1] Branch predictions: Dynamic: Keep track of former behavior and predict. Static: Guess based on target of jump (backward/forward). Hint: Compiler sticks a bit in the instruction. None: Eat the delay; sometimes fall-through is free.

[2] The number of functional units doesn't necessarily reflect how many instructions can execute in parallel. For example, under normal circumstances, the four functional units of the DEC Alpha will execute two instructions at once.

[3] General-purpose registers.

[4] Floating-point registers.

[5] Actually, there are three dedicated FPUs (add/multiply/divide), but they share pipeline stages so they cannot execute in parallel. Results will arrive one per cycle with full pipelines. The floating-point and integer instructions can't execute in parallel.

them less often by modifying loops.

In the first method, the compiler can sometimes figure out (using a method called *constant propagation*) how a conditional will evaluate. This lets the compiler eliminate the conditional and the code associated with the branch that won't be taken. The second transformation is a form of loop-invariant code motion; if there is a branch inside a loop that doesn't need to be there, move the branch outside the loop. Finally, the compiler can reduce the frequency of branching by combining loops or by iterating fewer times. One of the most common and most useful ways to reduce the number of iterations is to "unroll" the loop:

```
for i = 1 to 100
  A[i] = A[i] * 1.1
```

becomes

```
for i = 1 to 100 by 2
  A[i] = A[i] * 1.1
  A[i+1] = A[i+1] * 1.1
```

Here, the number of iterations, and hence the number of branches, is cut in half. Unrolling is a straightforward technique, although it becomes a bit more complicated to apply when the compiler doesn't know the loop bounds or if there are GOTO statements in the loop body. Despite its simplicity, unrolling a loop yields substantial performance improvements. This example unrolled four times yields a respectable 17 percent improvement in performance on the Hewlett-Packard PA-RISC.

Maximizing the Cache

The great thing about a cache is that you can ignore it; programs generally have good locality, so they execute much more efficiently when a cache is present. However, as memory has increasingly failed to keep pace with CPU speeds, compiler designers have begun to think about optimizing the use of the cache to avoid the deadly cost of excess memory references caused by cache misses.

A simple technique to avoid cache misses is to align data structures on cache boundaries. When a cache accesses memory, it loads a block of data called a *cache line*. The blocks are typically on the order of 16 words long. If a small data structure is aligned so that its first word of data is on a cache line boundary, a single memory transfer can load the entire structure. The same structure, straddling a boundary, would require two loads.

Aligning structures is a fine idea, but the real opportunity to benefit from cache management is in restructuring code. The kind of code that improves most dramatically—and is the easiest to manipulate—is the loop. Because they almost always represent the majority of execution time in a program and they have regular behavior, loops are the center of modern optimization research.

Caching provides the most benefit when data is reused many times after it is loaded from memory. The listing on the right shows how a loop can be restructured with a transformation called *blocking* (or *tiling*) to use the cache more effectively. The original code consists of two nested loops that walk over a 2-D array and compute a value for each element based on its four neighbors. The cache isn't big enough to hold the array, so some of the elements are reloaded unnecessarily. The compiler transformation divides the array into blocks of 50 by 50 elements, each of which is small enough to fit in the cache. It then converts the original two loops into four, where the outer two walk over blocks and the inner two perform the computation within a block. The transformation improves performance by 33 percent on an HP PA-RISC, despite the extra branch instructions added by the new loops.

The effect of blocking. *The improved reuse of the second loop yields a 33 percent improvement in performance on an HP PA-RISC, despite the extra branching necessary.*

```
real A[0..1001,0..1001]
Loop 1:
for i = 1 to 1000
  for j = 1 to 1000
    A[i,j] = (A[i-1,j] + A[i,j-1] + A[i+1,j]
        + A[i,j+1])/4
Loop 2:
for a = 1 to 1000 by 50
  for b = 1 to 1000 by 50
    for i = a to a+49
      for j = b to b+49
        A[i,j] = (A[i-1,j] + A[i,j-1] +
       A[i+1,j] + A[i,j+1])/4
```

Few commercial compilers do aggressive cache optimization yet, but it is an active area of research, and the ideas are migrating into industrial practice.

Register Considerations

The gulf between processor and memory speed has also led designers to take a different approach to the use of registers. Traditional architectures like the DEC VAX and Intel 80x86 have instructions that use values in registers, but they also have instructions that perform computations directly on values in memory. A key element of the RISC philosophy is the *load-store* architecture, in which all operations are performed on values stored in registers. To use values stored in memory, a program must first load them into a register.

Because register operations are so fast, RISC chips use as much extra silicon as possible to provide many more registers than older-style processors did. As the chart in the table shows, members of the new generation of processors generally have 64 registers. This abundance is a mixed blessing to compiler writers; while greatly improving performance, registers are another resource that needs to be managed carefully. The compiler has two opportunities for improving register usage: It can transform the code to increase reuse of intermediate values, and it can be intelligent in its register allocation strategy.

There are many transformations that improve locality, including loop unrolling. For example,

```
Loop 1:
for i = 1 to 100
  A[i] = A[i] + A[i+1]

Loop 2:
for i = 1 to 100 by 2
  A[i] = A[i] + A[i+1]
  A[i+1] = A[i+1] + A[i+2]
```

Loop 1 loads 200 values from memory Loop 2, the transformed one, loads only 150—the compiler puts `A[i+1]` in a register when it is loaded for the first statement and reuses it for the second. Further unrolling reduces the number of loads even more. Unrolling is only one of many loop optimizations that improve register usage.

Once it has transformed the code into its final form, the compiler must allocate registers. The usual strategy is to look at each procedure and figure out how many intermediate values need to be stored. The next step is to do *liveness* analysis; a value is "live" if some future computation needs to use it. After a value is no longer live, the compiler can reclaim the register that stored it and use it for another value. If more values are live at any given point than there are registers to hold them, some of the values are temporarily (and expensively) "spilled" to cache or memory. It is

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common to run out of registers on architectures like the Intel Pentium, which has relatively few available. For architectures with dozens of registers, the more usual reason to spill is a function call.

Every compiler has a calling convention that defines how function calls are made. The convention includes where the arguments go, which registers can be modified at will, which registers need to be preserved, and so forth. For example, if a processor has 64 registers, the compiler can stipulate that perhaps 32 of them can be modified arbitrarily by the called function. That means that the calling function must save any values in those 32 registers that it will need after the called function completes. The called function can't use the other 32 registers unless it saves their value first and restores it when the function is ready to return. Saving and restoring registers adds overhead to the cost of a function call; unfortunately for the compiler writer, modern programming techniques encourage the programmer to make many function calls.

Parallelism. *The RS/6000 has independent parallel floating-point and integer units. The first loop uses each unit per iteration. The second loop is the unrolled version of the first, exposing more parallelism and reducing the branching cost. It executes in 82 percent of the time needed by the first. The third loop has the same looping behavior as the second, but each statement depends on the previous one. This forces the loop to run much more slowly — it takes 36 percent more time to execute than does the original unrolled code.*

```
A is a floating point array
B is an integer array

       1
for i = 1 to 100
  A[i] = A[i] * 1.1
  B[i] = B[i] * 2

       2
for i = 1 to 100 by 2
  A[i] = A[i] * 1.1
  B[i] = B[i] * 2
  A[i+1] = A[i+1] * 1.1
  B[i+1] = B[i+1] * 2

       3
for i = 1 to 100 by 2
  A[i] = A[i] * 1.1
  B[i] = A[i] * 2
  A[i+1] = B[i] * 1.1
  B[i+1] = A[i+1] * 1.1
```

The compiler can make function calls much more efficient if it considers the interaction between procedures, rather than treating each one in isolation. Without knowing anything about the target of a call, the compiler has no choice but to preserve values conservatively—it is better to run slowly than incorrectly. However, if the procedure being called will use only some subset of the registers, the caller doesn't need to bother saving the others. Another trick is to assign frequently used values to registers permanently.

Multiple Functional Units

One of the most dramatic improvements in processor performance comes from low-level parallelism in the chip. Simpler architectures can execute only a single computation at once; so-called superscalar chips have multiple functional units that can be working on more than one result simultaneously. They can also issue more than one instruction at once. The instruction decode logic generally looks at the next few instructions to find one or more that are ready for execution. Some chips support *out of order* execution, meaning that they may execute instructions in a different order than they appear in the program.

Just like implicit delay slots, superscalar chips allow the compiler to act in ignorance; the chip will do its best to find and use parallelism. A smart compiler, though, tries to order instructions to take as much advantage of the multiple functional units as possible. Strategies for finding a good instruction sequence range in complexity from simple heuristics to detailed models of the target architecture.

The Intel Pentium is a good demonstration; it is a superscalar chip, but its predecessors were not. The Pentium is able to execute any 486 application unchanged, but performance will usually be much better if that application is recompiled. The recompilation doesn't change the basic computation, but it reorganizes the instructions so that they take better advantage of the chip.

For example, Watcom's 32-bit C++ compiler for DOS and Windows can perform "Pentium-aware" optimizations. The compiler accomplishes this by "RISCifying" the code; that is, by breaking each complex machine instruction in the emitted code into a series of simpler (though equivalent) instructions. The instructions in the "RISCified" code are then reordered where possible to take advantage of the Pentium's internal dual pipelines. A final pass recombines the simple instructions (again, where possible) into equivalent complex instructions to reduce the size of the final executable file.

To exploit multiple function units, an aggressive compiler begins by restructuring loops to expose more parallelism. Then it looks at each basic block and tries to find an instruction ordering that will minimize the instruction cycle count.

A tremendous variety of loop transformations have been proposed for exposing parallelism, including loop unrolling. The listing at left shows three loops and compares their performance on an IBM RS/6000 workstation.

The combination of multiple instruction issue and multiple functional units makes it difficult to figure out how long an instruction sequence will take to execute. Changes to the sequence can have strange effects; one of my favorite examples is what happened to some of my coworkers on the Mips architecture, who, to check the behavior of executables, modified them by inserting extra instructions at compile time. One program began to execute more quickly even though it was doing more work. After a frenzied attempt to figure out what was happening, they discovered that the Mips interlock imposes an extra penalty. When a conflict forces the chip to stall an instruction, not only does the instruction stop executing during the cycle, but it is penalized for causing trouble. The inserted instruction executed for free and, by preventing the interlock, caused the program as a whole to run faster.

This example brings home the point that, in the future, the compiler will be just as important as the processor in getting optimal performance for leading-edge operating systems and applications. ■

Oliver Sharp is an associate at Heuristicrats Research, Inc., a developer of optimization software. He is completing his Ph.D. in computer science at the University of California/Berkeley on compilation techniques for parallel architectures. You can reach him on BIX c/o "editors" or on the Internet at oliver@heuristicrat.com.

For More Information

This article is based on results coming from the compiler optimization community. To learn more, you need to resort to research papers. A comprehensive reference for traditional compiler techniques is *Compilers: Principles, Techniques, and Tools* by Aho, Sethi, and Ullman. You might find *High Performance Computing* from O'Reilly an interesting reference for figuring out how to make your code run faster. Before you worry about superscalar chips, however, make sure you've chosen your basic algorithms and data structures wisely. Jon Bentley's classic *Writing Efficient Programs* is an excellent place to start.

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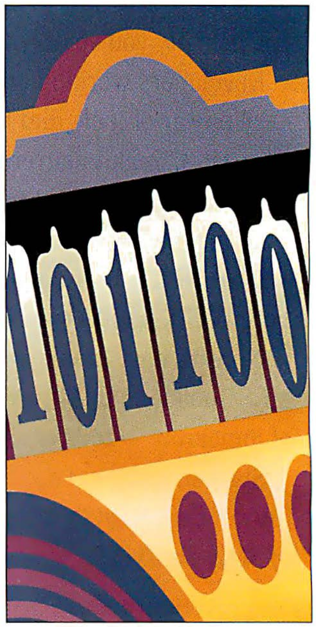
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Windows NT Supports Posix, but Does It Matter?

Posix is an important standard for character-based applications, but it may not have much of an impact in a windowcentric world

NICHOLAS BARAN



Technology

Microsoft is promoting its new top-of-the-line operating system, Windows NT, as the natural successor to Unix in environments requiring multitasking, high-level security, and conformance with federal standards. It is the first major operating system other than Unix to support Posix, which for years has been required for all government procurement contracts involving Unix-based systems. The question is whether NT's Posix support is merely a regulatory formality or a major technical feature.

Posix (for Portable Operating System Interface based on Unix) was intended to ensure application portability between Unix platforms. This initial standard required source code portability as specified in IEEE 1003.1 standard, which requires that system-level calls in the C language follow specific guidelines.

A second part of the Posix standard (IEEE 1003.2) provides a command-line interface standard as well as a number of shells and utilities, all based on Unix. (For example, `grep`, `awk`, and `lex`, are Unix commands that are standard functions in IEEE 1003.2.)

NT supports the entire IEEE 1003.1 standard and parts of IEEE 1003.2. The 1003.1 standard is supported in a "Posix subsystem" within NT, which lets programmers write C code in accordance with the 1003.1 standard. For example, Posix requires a specific method for handling process hierarchies and inheritance and uses a routine called `fork()` for this purpose, while NT's Win32 subsystem uses a routine called `CreateProcess()`.

Many 1003.2 components, such as `vi` and the Korn shell, are embodied in the NT resource kit, but 1003.2 support is not complete. A complete Unix-command interface for NT is available from third-party vendors such as Mortice Kern Systems of Toronto, Ontario.

Heart of the Matter

So the real question is: What good is Posix? The answer is that in its current state Posix is mainly good for satisfying federal procurement requirements. Even Posix supporters admit that the standard does not go far enough to ensure application portability between platforms. DEC's Jim Isaak, former chairman of the IEEE Posix committee, says, "Posix isn't rich enough to do many things that [applications developers] want to do—like control windows or the screen with something other than text I/O."

In other words, Posix only provides standards for developing character-based applications. With graphics and windowing systems, you're on your own. That's where NT hopes to fill the void. Developers can write Posix-compliant applications and then use the Win32 environment to create the graphics and windowing portions of their applications. Says Microsoft's director of business development, Bob Kruger, "The availability of NT in a Posix world is very significant because it fulfills the objectives that Posix was originally designed to fulfill: that is, portability, scalability, and multiplatform."

The U.S. government is not likely to standardize on NT. Currently, X Window System is the preferred (but not required) windowing standard in the Posix world and PHIGS and GKS are the dominating graphics standards.

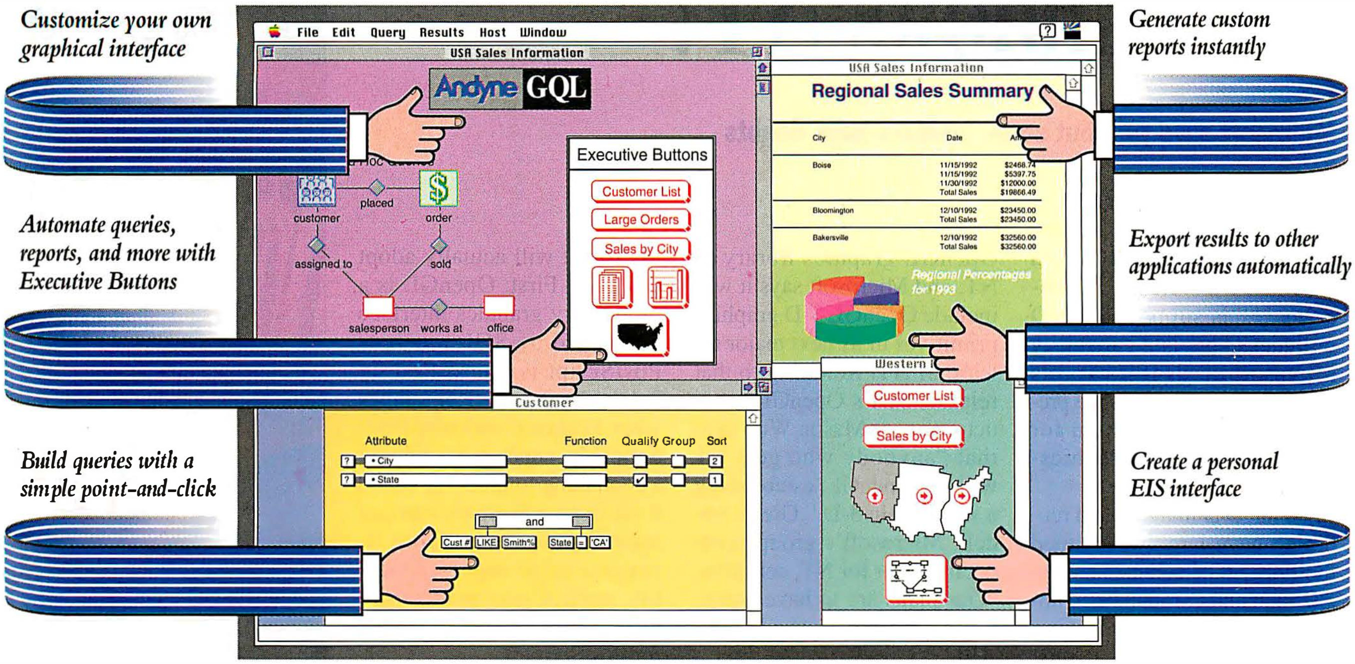
NT has the ingredients for becoming a standard, because it provides a complete set of tightly controlled programming specifications from text to graphics, unlike Unix, which spawned a myriad of different versions and graphics and windowing standards. According to Kruger, "Unix and NT started out with a different focus historically. Unix started out as a lab exercise as opposed to a commercial product."

Incompatible and nonportable applications will continue to exist unless the world switches to NT or an alternative system. And although Microsoft may spend millions to promote NT's cause, it's not likely to happen. Unix is by no means dead, and it's hard to imagine DEC, Sun Microsystems, and Hewlett-Packard dropping their investment in X Window–based applications to adopt the Win32 environment. Isaak sums it up: "We haven't escaped the problem we're trying to address: application portability." ■

Nicholas Baran is a BYTE consulting editor living in Sandpoint, Idaho. He is the author of Windows from the Keyboard *(John Wiley & Sons, 1993). You can reach him on BIX as "nickbaran."*

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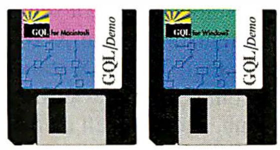
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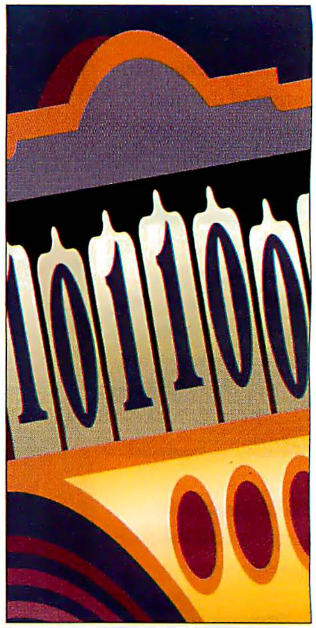
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Will OpenGL Be 3-D Standard for Windows NT?



Technology

Microsoft says yes, but some insiders have doubts

NICHOLAS BARAN

Conspicuously absent in the first release of Windows NT is support for 3-D graphics. This is a capability Microsoft needs if it expects NT to overtake Unix as the preferred operating system for high-performance graphics-intensive applications.

So far, 3-D imaging and rendering have largely remained the domain of scientific visualization and computerized animation applications running on expensive workstations, such as Silicon Graphics, Inc.'s, Iris. But with the relentless drop in hardware price/performance and the advent of multimedia as a broad-based technology, 3-D graphics is poised to become a common component in many applications and is of critical importance to Windows NT.

Workstation 3-D graphics are dominated today by two competing standards: OpenGL from SGI, and PEXLIB, a consortium based at MIT that has developed PEX, a set of 3-D extensions to the X Window System. The PEX standard is promoted by Hewlett-Packard, Sun, and IBM, all members of COSE (the Cooperative Operating System Environment), the alliance attempting to "unify" Unix. IBM also supports OpenGL, as do DEC, NEC, and Intergraph.

Windows NT presents a major new platform for 3-D applications. SGI is porting its OpenGL graphics library to NT, and Microsoft says it will include OpenGL 3-D graphics primitives in its next major release of NT. Referring to that release, SGI's OpenGL product manager Mason Woo says that "anybody who gets NT will get OpenGL, establishing a standard in 3-D." Greg Lobdell, Microsoft's group product manager for NT, confirms, "Our plans are to have OpenGL primitives in the Win32 API."

It's anybody's guess when this "next major release" will be available, but it's not likely to be until late next year. Lobdell told BYTE that OpenGL for NT is in beta testing now but declined to give an actual release schedule. Meanwhile, Media Vision (Santa Clara, CA), which was founded by former SGI engineers, has already released a version of OpenGL for Windows NT that it claims will be fully compatible with the future Microsoft version of OpenGL. The Media Vision OpenGL runs on Intel, DEC Alpha, and Mips platforms. Intergraph is also working on its own implementation of OpenGL for NT.

Stormy Horizon

Although Microsoft's official line is that OpenGL will be the 3-D standard for NT, there are some questions. One insider in the 3-D graphics business, who requested anonymity, doubts Microsoft will actually adopt OpenGL. First, OpenGL is a proprietary graphics interface controlled by SGI, much as PostScript is controlled by Adobe Systems. (Remember when Microsoft endorsed PostScript? It ended up developing a competing font library called TrueType.) Graphics board manufacturers pay SGI a licensing fee to support OpenGL, much as laser-printer manufacturers pay a fee to Adobe for PostScript.

Second, one of Microsoft's key software vendors for Windows NT is AutoDesk, maker of the hugely successful AutoCAD. And AutoDesk has recently acquired Ithaca Software, which makes a 3-D graphics development interface called HOOPS. HOOPS works with both OpenGL and PEX, as well as with various 2-D interfaces, such as Microsoft's GDI (Graphical Device Interface) and Apple's QuickDraw. AutoDesk may be reluctant to throw its support exclusively to SGI when it owns a development tool that works with other graphics interfaces. Lobdell sidestepped the issue by saying, "It's not clear whether we'll support other 3-D standards."

It also seems unlikely that Microsoft will standardize on another company's proprietary 3-D interface. That just isn't how Microsoft operates. One possible scenario is that Microsoft is developing its own library of 3-D extensions to GDI and is merely supporting OpenGL in the near term, until it can release its own solution.

Microsoft certainly has the resources to develop its own 3-D extensions to GDI, and it would then control its own 3-D interface and compete with SGI and PEXLIB. But Microsoft's Lobdell discounts this theory: "OpenGL is where most of the momentum is now, and we're trying to avoid redundancy, so we probably wouldn't invent another set of 3-D primitives."

Time will tell. At the moment, OpenGL looks like it's in the driver's seat. ■

Nicholas Baran is a BYTE consulting editor living in Sandpoint, Idaho. He is the author of Windows from the Keyboard *(John Wiley and Sons, 1993). You can reach him on BIX as "nickbaran."*

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OS/2 Gets Device Support

IBM finally makes it easy for hardware vendors to support OS/2

STEVE MASTRIANNI

Perhaps the most notable improvement in OS/2 2.1 over version 2.0 is the newer version's dramatically increased support for third-party expansion hardware. For example, for the first time ever, I'm able to run my ATI Graphics Ultra Plus in 1280- by 1024-pixel-resolution mode, with 256 colors. Users of S3-based video boards are reporting similar success. Admittedly, these drivers are in beta, but they will soon be generally available.

By the time you read this, OS/2 will likely support most of the state-of-the-art video accelerator chip sets from companies such as S3, ATI, and Weitek. It will also claim support for non-SCSI CD-ROM drives, 24-bit color printers, scanners, touchscreens, and a host of other input and output devices.

This situation is unusual for OS/2, to say the least. For most of its existence, the operating system has lacked meaningful support for third-party hardware. The major reason for this situation has been the lack of a DDK (device-driver toolkit) from IBM. OS/2 device drivers are difficult to write under the best of circumstances. Without samples, they are nearly impossible.

Driver History

When OS/2 2.0 was released, the only existing OS/2 device-driver toolkit was the Microsoft DDK, which Microsoft had already pulled from the market. Moreover, many things had changed in OS/2 2.0 that precluded the use of the Microsoft DDK with this new version. The kernel debugger, which was version-specific, was not able to work with OS/2 2.0. In addition, IBM replaced the Microsoft LADDR (Layered Device Driver) architecture with the ADD (Adapter Device Driver) architecture, and the Microsoft Strategy 2 disk driver interface was replaced by IBM's EDDI (Extended Disk Driver Interface).

Changes in DOS compatibility also affected device drivers. OS/2 1.x supported only one DOS session, in which the processor actually operated in real mode. OS/2 2.0, however, introduced multiple VDMs (virtual DOS machines), which allowed each DOS program to run in its own 1-MB memory space, completely unaware of any other running applications. These programs needed to have shared access to I/O devices even though they assumed that they had exclusive access to them.

IBM's solution is the VDD, or virtual device driver, which arbitrates ownership of the device. The VDD has also virtualized the common system devices, such as the clock, the serial ports, and the DMA controller.

VDDs are 32-bit DLLs, which brought up yet another problem—namely, that there were no existing 32-bit compilers for OS/2 when version 2.0 shipped. IBM had used a Microsoft 32-bit compiler, but it could not distribute the compiler externally. As a result, developers were forced to write VDDs in assembly language or not at all.

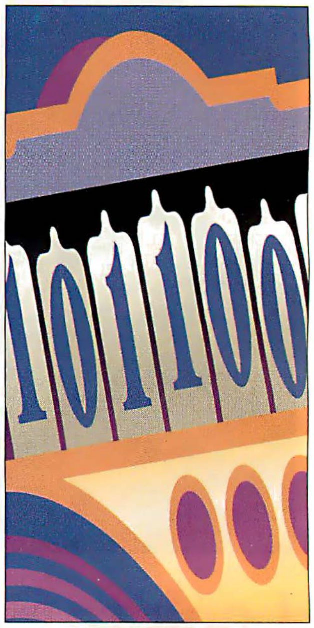
The Turnaround

As a result of all these problems, device-driver support for OS/2 2.0 was nonexistent. Late in 1992, IBM finally realized that the lack of device support was hindering OS/2 2.0's success and would also hurt the expected success of OS/2 2.1.

Under the direction of Lois Dimpfel, director of IBM's Personal Operating Systems division, a group was formed in Boca Raton to make enhanced device support a reality. The group consisted of device-driver experts from all parts of IBM. Dubbed the Worldwide Industry Hardware Support department, it was given a simple mission: do whatever was necessary to make enhanced OS/2 device support a reality.

The culmination of the IBM group's effort was the release of the first beta DDK in early 1993. To ensure that it received feedback from a large number of developers, IBM released the beta DDK for a nominal charge of $15. The DDK was available only on CD-ROM because of its size and complexity, and it included the previously unreleased 32-bit C compiler to make it possible to write VDDs in C.

The first commercial DDK was released a few months later. Dubbed the IBM Device Driver Sourcekit 1.0, the DDK contained more than 70 device-driver sources, as well as a large set of on-line documentation. Included were sources to the mouse, disk, CD-ROM, serial, printer, and floppy disk drivers, as well as a modest collection of device-driver test tools.



Technology

In July of this year, IBM held the first-ever IBM OS/2 Device Driver Conference. This conference was attended by more than 300 OS/2 device-driver developers. Today, drivers for all types of devices are at last beginning to appear, spurred on not only by the efforts of the Boca Raton team, but by the success of OS/2 2.1 as well. IBM has put OS/2 device support back on the right track. ■

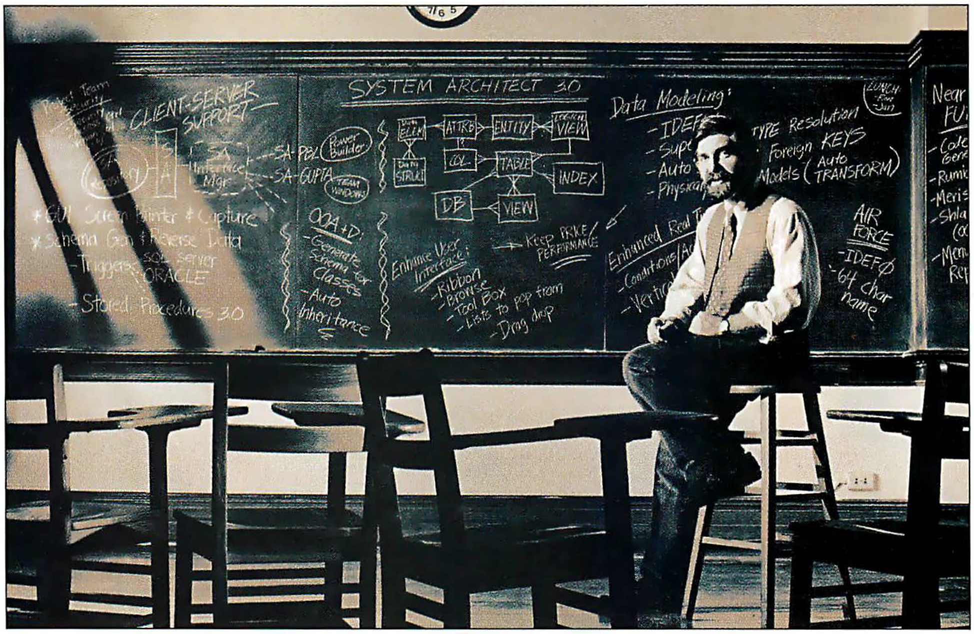
Steve Mastrianni is president of Personal Systems Software in Canton, Connecticut. He specializes in device drivers, operating systems, and real-time applications for OS/2 and Windows NT. You can reach him on BIX as "smastrianni," on the Internet at smastrianni@bix.com, or on CompuServe at 71501,1652.

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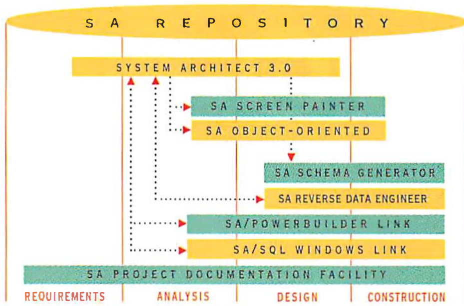
SA Screen Painter: Allows repository-based development of GUI screens and menus or character-based screens.

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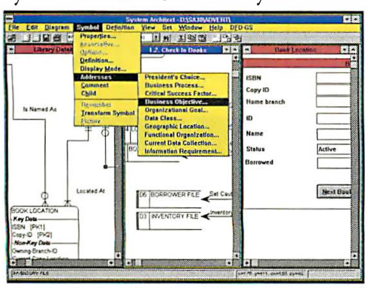
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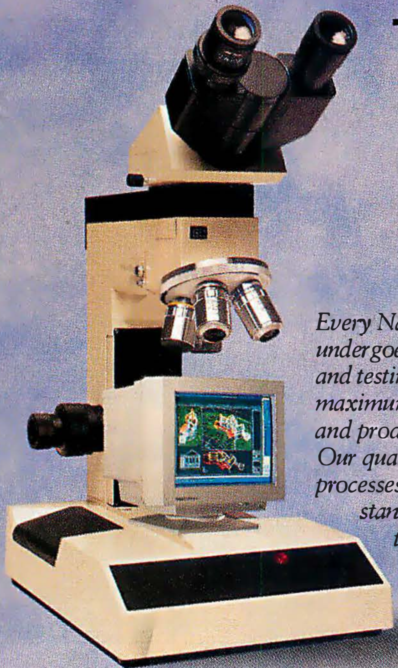
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Superior In E



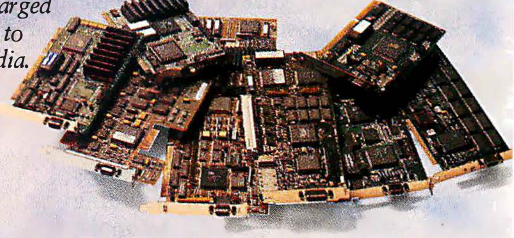
Every Nanao monitor undergoes intense scrutiny and testing to ensure maximum performance and product reliability. Our quality control processes and technical standards are among the most rigorous in the industry.

Our new line of Ecological Design™ Monitors incorporates advanced energy-saving features including PowerManager, which cuts power as much as 93% when the monitor is not in use. (After Dark screen saver software free with each monitor.)



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Nanao FLEXSCAN technology is compatible with all of today's popular graphics cards, offering a viewing environment ranging from enlarged graphics to multimedia.

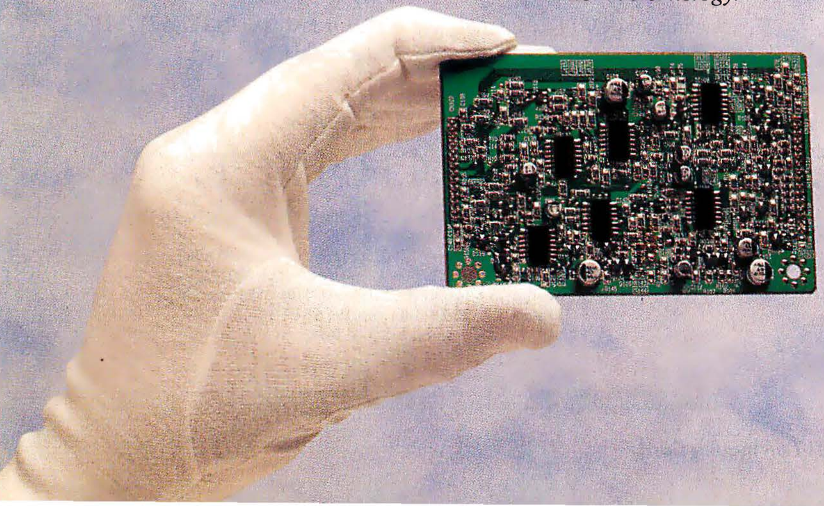


MPR II

Nanao's FLEXSCAN family of monitors meets safety specifications for radiation emissions established by the Swedish MPR-II guidelines as well as those of TCO, the Swedish Confederation of Professional Employees. Nanao was the first monitor manufacturer to achieve FCC Class B approval for our 80kHz frequency monitors.

REDUCED ELECTROMAGNETIC FIELDS TCO 1992 AUTOMATIC DISPLAY POWER DOWN

High quality PCB boards are assembled, adjusted and inspected at Nanao's special chip-mounting factory. All PCB boards are built using sophisticated surface-mount technology.



Model	Size	Dot Pitch	Scan Frequency	Recommended Resolution
T660*i*	20"	0.30mm	H:30-82kHz V:55-90Hz	1280x1024
T560*i*	17"	0.25mm	H:30-82kHz V:55-90Hz	1280x1024
F760*i*•W	21"	0.31mm	H:30-78kHz V:55-90Hz	1280x1024
F560*i*•W	17"	0.26mm	H:30-82kHz V:55-90Hz	1280x1024
F550*i*•W	17"	0.28mm	H:27-65kHz V:55-90Hz	1024x768
F340*i*•W	15"	0.28mm	H:27-61.5kHz V:55-90Hz	1024x768

Nanao T-Series and F-Series monitors have captured every major award.



very Detail.

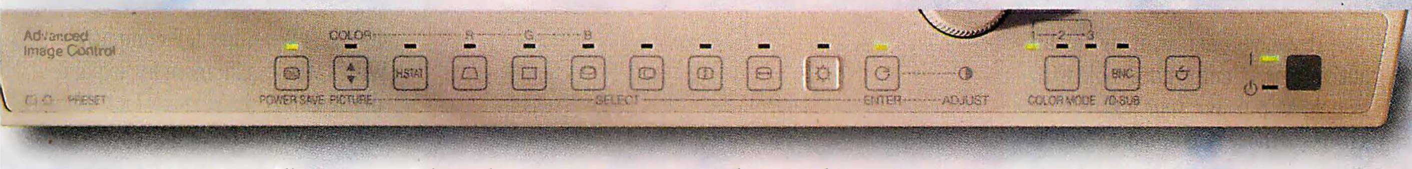


Our high resolution CRTs deliver a complete range of color displays with photographic quality and brilliant color images to sophisticated applications like CAD, DTP and multimedia. TRINITRON® CRT models offer greater precision and intricate detail, while Nanao's Invar Shadow Mask Flat Screen CRT models provide a wide display area and lower distortion image. Both CRTs feature our unique built-in Dynamic Beam Spot Control System that ensures maximum brightness and sharp focus.



A heritage of precision craftsmanship and attention to detail has been designed into Nanao's family of display monitors.

To reduce glare, eliminate static electricity, and improve the focus level on the display area, Nanao has developed two anti-reflective innovations: ErgoCoat,™ a protective coating for all F-series monitors, and ErgoPanel,™ a sturdy panel that covers the surface of our T-series monitors.



Our user-friendly front control panel incorporates ergonomic design and ease-of-use as well as a variety of powerful options for customizing images.



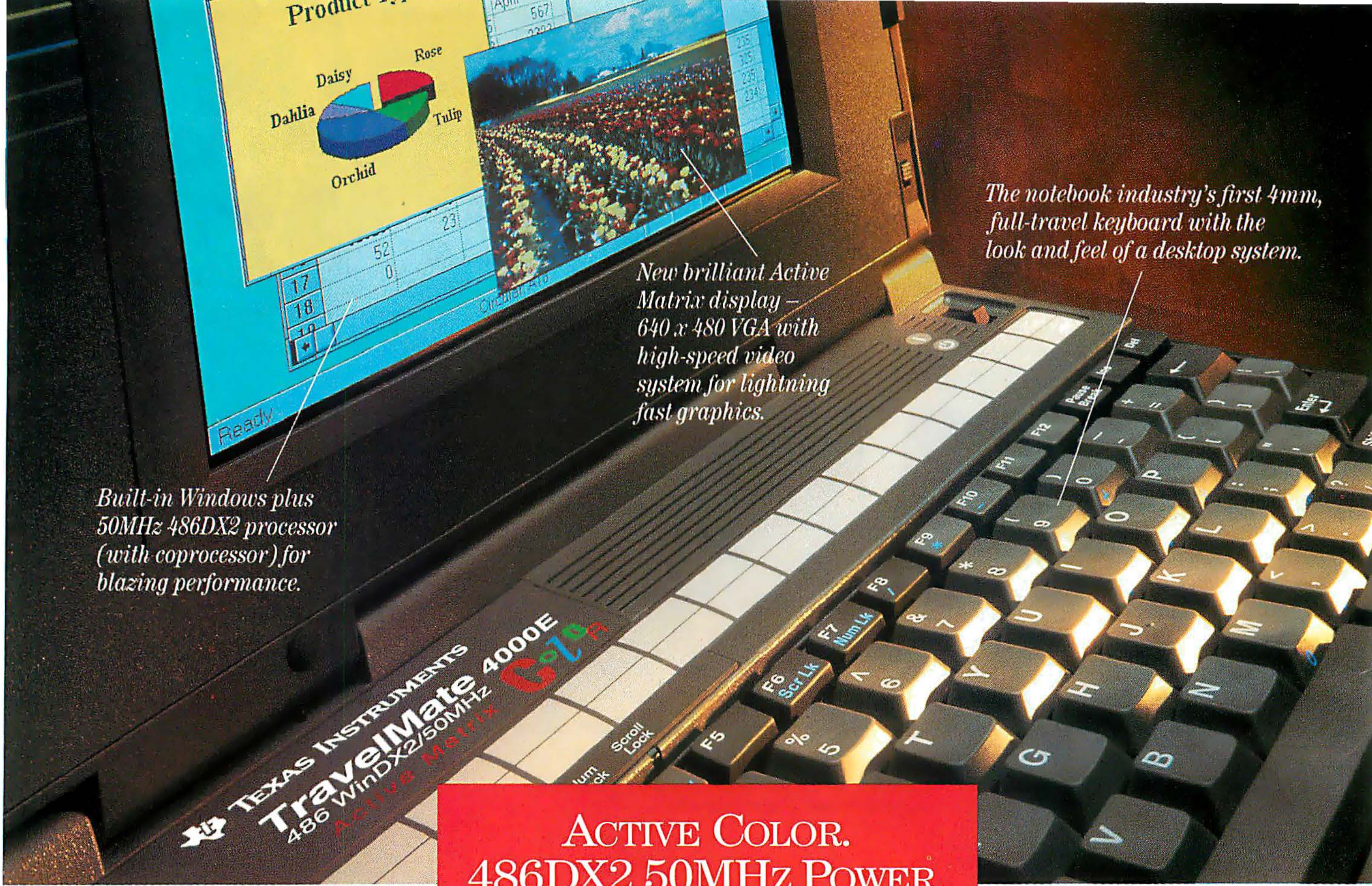
At Nanao, details make all the difference in creating our family of professional display monitors. From the product design and manufacturing that takes place in our factory to the end user's working environment, Nanao pays attention to every detail. In engineering. Assembly. Product testing. Quality control. Shipping. Customer support. From the very first days of the company, we set out to be an innovator in monitor technology. And, in a few short years, we have achieved that goal. Today, Nanao has the lowest repair rate in the monitor industry, the highest product reliability, and a fast-growing number of enthusiastic customers. So if you're looking for a superior monitor, start with the details. We do.



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50MHz DX2 processor with coprocessor provides desktop performance in a notebook.



With 256 brilliant, simultaneous colors and a 50MHz 486DX2 processor, this powerhouse doesn't just whisper color, it screams it.

And yet the TravelMate 4000E weighs a mere 6.2 pounds, including battery. This convenient size and weight gives you more performance* than the leading 486 notebooks. And the industry's first 4mm, full-travel keyboard gives you the feel of a desktop.

Of the leading active matrix color notebook manufacturers, only TI offers the desktop performance of a 50MHz DX2 processor.

Active Color Notebook	*Weight (lbs.)*	*486 Processor*	*Speed*	*Coprocessor*
TravelMate 4000E	**6.2**	**DX2**	**50MHz**	**Yes**
Toshiba T4600C	6.9	SL	33MHz	Yes
Compaq LTE Lite 4/33c	6.5	SL	33MHz	Yes
IBM ThinkPad 720C	7.6	SLC2	50MHz	No

Thanks to built-in Windows 3.1 and useful TI utilities, you can power up to Windows in just 15 seconds. And the TravelMate 4000E is Windows NT-compatible. With 4MB of main memory, expandable to 20MB, you're ready for today's and tomorrow's software.

If you work on the go, you'll also go for the rugged 200MB hard disk drive, the high-speed video bus and 1MB of video RAM, as well as the full range of connectivity options – snap-on modules for Ethernet® LANs, SCSI-compatible devices and an internal 14,400 bps V.32 bis modem with 9,600 bps send/receive fax capability.

For more information about the only 486 notebook family that won five Editor's Choice awards in PC Magazine's August issue, call *1-800-527-3500*.

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Top Software for Windows & OS/2

A compendium of top programs and tools for Windows and OS/2 users—word processors, databases, spreadsheets, programming tools, graphics packages, communications software, and utilities

COMPILED BY ANNE LENT

The number of programs for Windows users has grown to the point that you could lay them all end to end and probably span several time zones. Well, that's a bit of a stretch, but the fact is, the number of Windows applications is in the thousands. The number of OS/2 applications is nothing to laugh at, either—a directory published by IBM lists more than 1400 software packages that run under OS/2. Some of them are vertically inclined—programs for computing fluid dynamics, for example, or managing a fleet of trucks. The bottom line is this: There's a Windows or OS/2 program for doing just about anything you'd want to do with a computer. (That's not the case with Windows NT—yet. Applications for that 32-bit operating system are mostly still in the announcement stage.) This guide will point you to some of the best applications for Windows and OS/2. Whether you're looking for a word processor, database, spreadsheet, programming tool, graphics package, presentation program, or utility, you'll find the best choices covered here.

WORD PROCESSING

Ami Pro 3.0 for Windows and OS/2

Ami Pro 3.0 features Fast Format for automated text formatting, drag and drop editing, and SmartClick for access to settings and controls. Also included are document and style-sheet viewers and a Clean Screen feature that lets you maximize your workspace by removing elements such as the title bar, menus, scroll bars, and SmartIcons.



The word processor includes a macro language, a spelling checker, a thesaurus, footnote and endnote support, automatic indexing, a four-level undo command, and a tables facility. You can create tables of contents that are up to nine levels deep. Ami Pro 3.0 supports OLE and all major Windows-supported networks, according to Lotus.

$495
Lotus Development Corp., Atlanta, GA; (404) 391-0011; fax: (404) 698-7653
Circle 1320 on Inquiry Card.

CA-Textor for Windows and OS/2

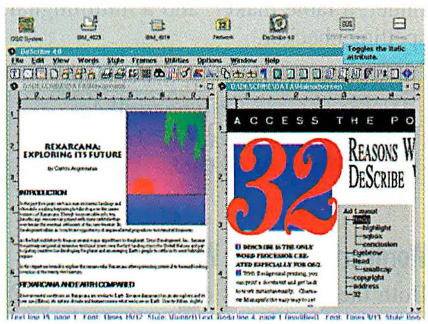
Computer Associates calls CA-Textor a professional word processing tool. The interface uses pull-down menus, pop-up dialog boxes, and a user-configurable toolbar. Word processing features include user-defined dictionaries, a spelling checker, a thesaurus, WYSIWYG text editing, standard and draft mode, a multiple document interface, embedded graphics, a table editor, and a calculator. CA-Textor also offers a full document history that lists a file's author, last version date, time, and version number.

According to Computer Associates, the program can import CGM, TIFF, WFF, WPG, and BMP files and can import and export WordPerfect, Word, RTF, and ASCII files. CA-Textor supports DDE and PostScript printing.

$195
Computer Associates International, Inc., Islandia, NY; (516) 342-5224
Circle 1321 on Inquiry Card.

DeScribe 4.0 for OS/2

DeScribe, the first word processor written for OS/2, is a native 32-bit application. With the ability to multitask and multithread, DeScribe can perform several tasks simultaneously so that you can continue working in an application while another operation is under way. To run DeScribe 4.0 you need OS/2 2.0 or 2.1.



$495
DeScribe, Inc., Sacramento, CA; (916) 646-1111; fax: (916) 923-3447
Circle 1322 on Inquiry Card.

Q&A Write

Symantec's Q&A Write 3.0 for Windows lets you create documents and mail merge them with database formats such as Paradox and dBase. The program uses 1.7 MB of hard disk space, making it useful for portables, Symantec says. Q&A Write also provides automatic, transparent file conversion from Word and WordPerfect.

The package has a sort-and-retrieve function for creating targeted mailings. It lets you select entries from a merge database based on various criteria. Q&A Write offers fax and mail support for products such as cc:Mail and Microsoft Mail. The program supports file sharing over networks and OLE and DDE links.

$69.95
Symantec Corp., Cupertino, CA; (408) 253-9600
Circle 1323 on Inquiry Card.

Word for Windows 6.0

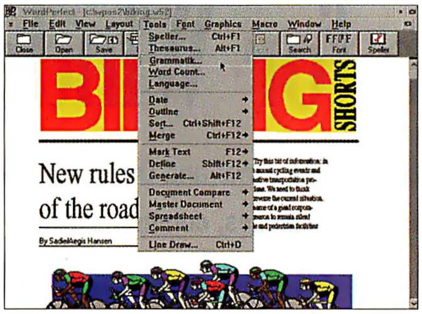
Microsoft says that when developing the new Word 6.0 for Windows, the company focused on "core" word processing tasks such as entering text, manipulating text, and formatting text. Word 6.0 for Windows offers new, automatic features that perform some of the common word processing tasks for you, Microsoft reports. Also added are features such as Wizards (on-line assistants) and on-the-fly spelling and grammar checking. As in its predecessor, version 6.0 features a customizable toolbar, drag-and-drop ability, a file finder, a table maker, and a multilingual spelling checker.

Price not available at press time.
Microsoft Corp., Redmond, WA; (206) 882-8080; fax: (206) 883-8101
Circle 1324 on Inquiry Card.

WordPerfect 5.2 for Windows and OS/2

Both these versions of WordPerfect 5.2 provide tools that are designed to speed up word processing tasks: the Button Bar, a group of buttons that access major functions and macros, and QuickMenu, which lets you switch among and make changes to buttons. The Ruler lets you change tables, fonts, and zoom percentages, along with margins and column borders; it also lets you create columns and tables by dragging the mouse.

WordPerfect 5.2 for Windows and for



OS/2 are both file-compatible with WordPerfect 5.1 for DOS. The program supports drag-and-drop text editing, OLE, DDE, MAPI, and VIM. The product ships with the Grammatik 5 grammar checker and Adobe Type Manager.

$495
WordPerfect Corp., Orem, UT; (801) 225-5000; fax: (801) 222-5077
Circle 1325 on Inquiry Card.

XyWrite for Windows

XyWrite for DOS, favored by writers and editors, is now available in a Windows version. The Technology Group is calling it the only Windows word processor with a command line. It offers customization options, an intuitive interface, and straightforward word processing, according to The Technology Group.

Features include Named Log and Resume, which lets you create multiple notebooks to hold different work projects; Auto Replace, which lets you create a glossary of shorthand notation and expand personal abbreviations as you type them; a Styles capability that helps you maintain uniform formatting over long projects; and a library of buttons that you can use to initiate common commands.

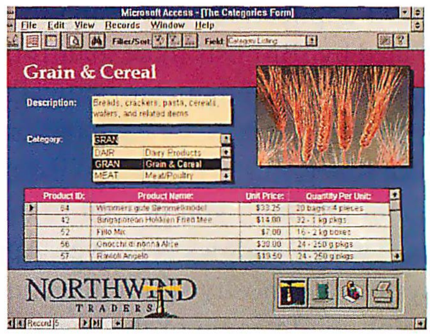
$495
The Technology Group, Baltimore, MD; (410) 576-2040; fax: (410) 576-1968
Circle 1326 on Inquiry Card.

DATABASES

Access 1.1

Microsoft's Access is a relational database designed to offer transparent access to data as well as provide a full development environment, according to the company. Using Form Wizards, Report Wizards, and Graph Wizards, you can build forms, reports, and graphs. You can also create your own custom Wizards. To make the product easy to use, Microsoft included Cue Cards, which offer task-sensitive instructions on screen that include self-running demonstrations on how to complete tasks.

Access 1.1 supports Oracle, Sybase, and SQL Server database servers as well as NetWare, LAN Manager, Vines, 3+Open, IBM LAN Server, and NetBIOS network operating systems. Programming features include a procedural language, access to DLLs, data-entry forms, user-defined functions, page and file locking, event processing, and object-oriented features. File



formats that you can import and export include ASCII, dBase, Lotus 1-2-3, Paradox, and Excel. The maximum number of fields per record is 255, with no limit on the number of records per table. Access requires Windows 3.0 or higher with at least 4 MB of RAM.

$495
Microsoft Corp., Redmond, WA; (206) 882-8080; fax: (206) 883-8101
Circle 1327 on Inquiry Card.

Approach 2.0 for Windows

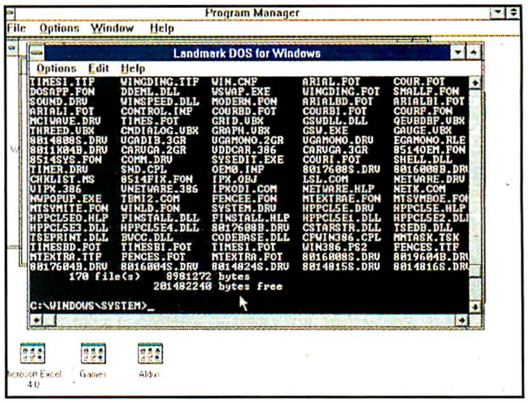
Approach, recently acquired by Lotus, is a relational database that lets you link up to 10 databases at a time. You can also mix data from multiple file formats on a single report, form, form letter, or mailing label.

Approach uses PowerKey technology, which gives you access to any dBase, Paradox, FoxPro, Oracle SQL, SQL Server, or DB2 file. You update, analyze, and report on the data in its native format, with no filters or importing involved. Approach offers OLE and TrueType support, drag-and-drop capability, "sounds like" searches, record and field locking ability, event processing, conditional branching,

At last, new software provides Windows™ users all the advantages of DOS...

"How to get the flexibility, speed, and power of DOS while using Windows."

If you like DOS commands, but work in Windows anyway, then you need new **Landmark DOS for Windows.** Landmark DOS for Windows is a fully functioning, scalable window that operates virtually all the DOS commands right from within Windows.



No more switching from Windows to the DOS shell!

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Run DOS internal commands from Windows!

Now you can run DOS internal commands like DIR, pipes, and redirects. **Landmark DOS for Windows** makes writing power BATCH files a breeze. And, **Landmark DOS for Windows** includes 23 new commands like GETINI and SETINI for command line .INI file editing.

Eliminate memory overload.

The DOS shell requires 256K of RAM and doesn't even know Windows is running! **Landmark DOS for Windows** is a true Windows program whose memory size and location is entirely controlled by Windows. You'll get all the benefits of DOS (and more) without suffering the 'out of memory' message.

Run DOS and Windows apps from the command line.

With **Landmark DOS for Windows** you get the best of both worlds - DOS power and flexibility and Windows graphics and features. You can run either DOS or Windows applications right from the command line. You can even use your mouse to click on the application name or associated file to launch the program. And, for real power BATCH files, you can launch both DOS and Windows applications in any sequence right from within Windows.

Perform superior multitasking safely.

Since **Landmark DOS for Windows** is a true Windows application, it doesn't depend on the risky time-slice multitasking of DOS in Windows 386 enhanced mode. The result is much smoother and safer multitasking.

Increase operating speed and save time.

With the flexibility of DOS commands available right in Windows you'll dramatically increase your operating speed and slash wasted time waiting and switching between the DOS shell and Windows. Time is money, **Landmark DOS for Windows** makes you much more productive!

Dozens of new DOS commands!

- **DATECOPY:** Perform quick and easy daily backups by today's date.
- **FF:** Find File quickly locates any file or group of files by name.
- **TS:** Search files for specific text when you forget the file name.
- **CDD:** Change the drive and directory in one command.
- **TOUCH:** Resets the DOS date/time on all files described to the current date and time (works great before DATECOPY for flexible backups).
- **MOVE:** Move subdirectory and contents to another directory.
- **DELDIR:** Delete an entire subdirectory and its contents in one command.
- **NUKE:** Delete and overwrite any file for security (cannot be un-deleted).
- **GETINI:** Reports any .INI files that match input variable.
- **SETINI:** FAST command line editing of your .INI.
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the ability to perform SQL queries, and more. The database also supports database servers and networks. Approach 2.0 requires at least 2 MB of RAM. The maximum number of fields per record is 256, with no limit on the number of records per table.

$399
Lotus Development Corp., Cambridge, MA; (617) 577-8500
Circle 1328 on Inquiry Card.

askSam for Windows

According to askSam Systems, askSam for Windows is a free-form database that is easy to use. Using the Windows Clipboard, you can copy information from other applications into askSam. Import formats include ASCII, WordPerfect, dBase, and RTF. Search capability includes Boolean, date, numeric, hypertext, proximity, and full text. The program also supports OLE and TrueType.

The following predefined templates come with askSam: address, calendar, clippings, E-mail, notes, questionnaire, phone directory, to-do list, and more.

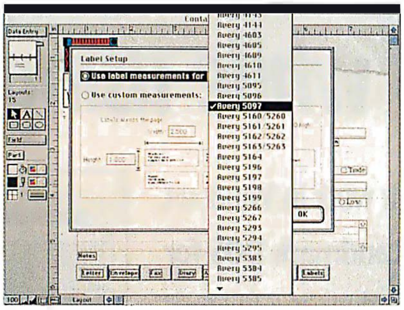
The database supports an unlimited number of fields per record. It also supports sequential number generation and variable-length fields. It does not support database servers or networks. To run askSam you need at least Windows 3.1 and 4 MB of RAM.

$395
askSam Systems, Perry, FL; (904) 584-6590
Circle 1329 on Inquiry Card.

FileMaker Pro 2.1

FileMaker Pro 2.1 for Windows lets PC and Mac users share multiuser database applications with a single menu selection across LANs. FileMaker Pro 2.1 supports NetBIOS API and Novell's MacIPX. It also is compatible with NetWare, Banyan Vines, LANtastic, and other NetBIOS networks. It supports QuickTime for Windows, so you can add full-motion video, animation, and digital sound to your databases. It also supports DDE, Windows for Workgroups, and MAPI.

Features included in FileMaker Pro 2.1 are predesigned business templates for use in invoicing, inventory management, lead tracking, contact management, project

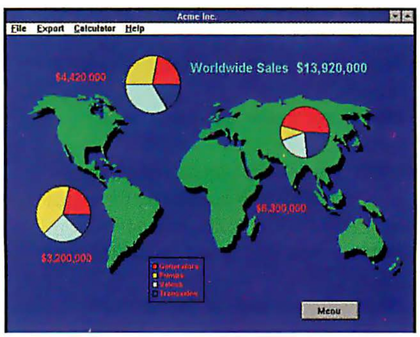


tracking, mailing lists, and more. ScriptMaker lets you streamline repetitive tasks with mouse-driven scripts. Intelligent Field Formatting lets you use radio buttons, check boxes, and pop-up lists. The Auto Indexing feature lets you select and retrieve information based on any defined criteria without specifying key fields. You can have an unlimited number of fields per record and records per table. Graphics tools let you create and place boxes, lines, and other graphics anywhere in a report.

$399
Claris Corp., Santa Clara, CA; (408) 727-8227
Circle 1330 on Inquiry Card.

Forest & Trees

Trinzic, formerly Channel Computing, calls Forest & Trees a client/server data-analysis and reporting tool. It lets you collect, combine, monitor, and analyze information from a variety of sources such as spreadsheets, databases, mainframes, and Lotus Notes. Forest & Trees uses an ANSI-SQL-compatible query engine. It



can import data from Lotus 1-2-3, Excel, dBase, Notes, and several database servers, including Oracle, NetWare SQL, Sybase, and Gupta SQLbase.

Forest & Trees lets you monitor data sources automatically through scheduled queries, preset alarm conditions, and alarm triggers. Alarm triggers can execute query calculation, report or graph printouts, E-mail, and formula calculations based on changes in your data.

According to Trinzic, a WYSIWYG report writer lets you create reports with an object-oriented layout tool. The program can collect up to 100,000 data points per view, with date and time of calculation and values. Forest & Trees can communicate with other Windows programs as a DDE server. To run Forest & Trees, you need Windows 3.0 or higher and at least 2 MB of RAM.

$695, standard edition; $790, client/server edition
Trinzic Corp., Portsmouth, NH; (603) 427-0444
Circle 1331 on Inquiry Card.

FoxPro 2.5 for Windows

With FoxPro 2.5, Microsoft extended the query optimization of its Rushmore technology, making it, according to Microsoft, up to three times faster than FoxPro 2.0. By combining Rushmore's query optimizer with relational query by example, you can retrieve data from multiple databases without coding.

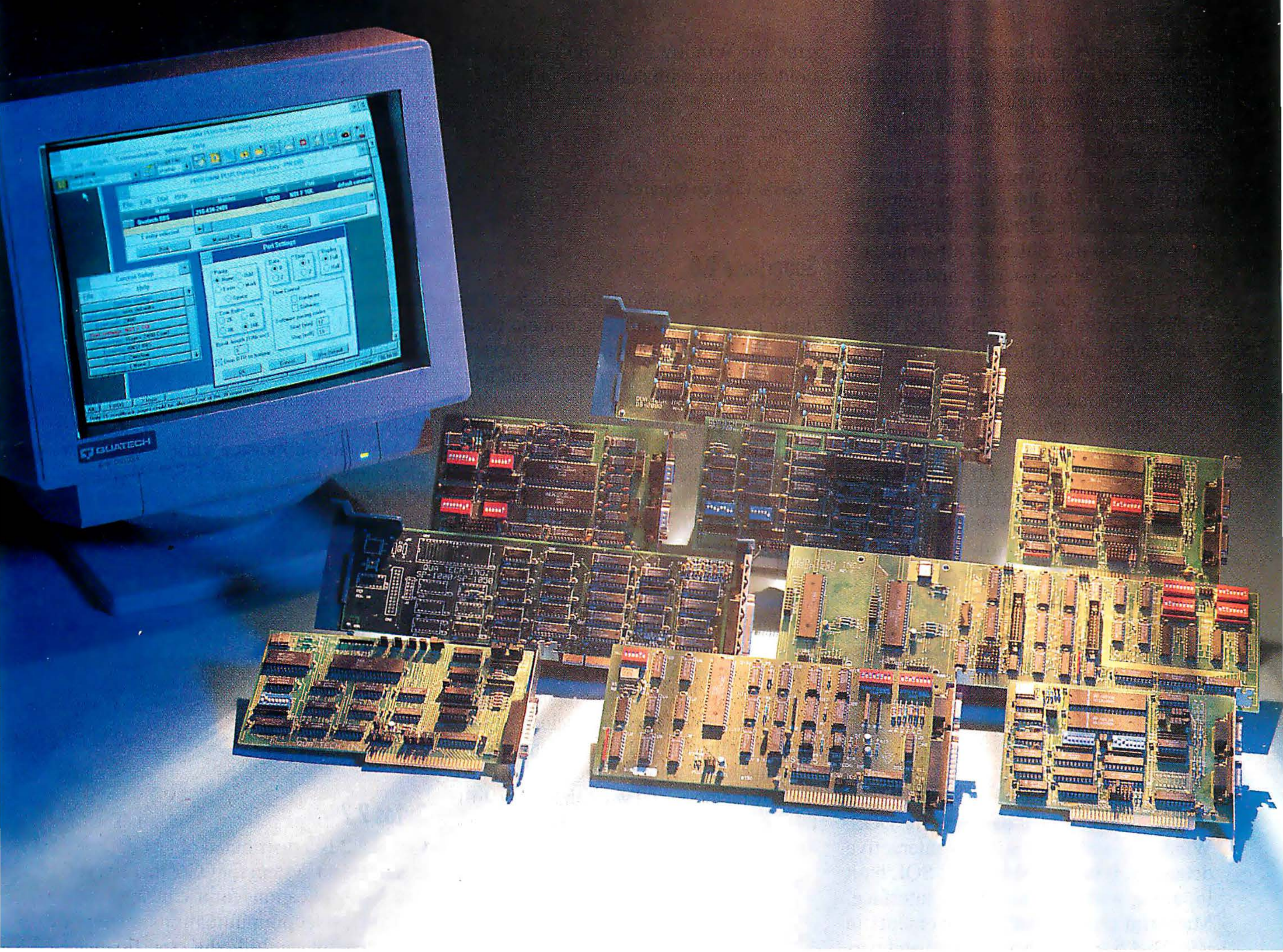
FoxPro 2.5 supports Oracle, Sybase, SQL Server database servers, and NetWare, LAN Manager, Vines, 3+Open, IBM LAN Server, and NetBIOS network operating systems. Programming features include a procedural language, access to DLLs, data-entry forms, user-defined functions, record and field locking, and event processing. DDE, OLE client, and TrueType are supported. FoxPro 2.5 imports ASCII, dBase, Lotus 1-2-3, Paradox, and Excel files. The maximum number of fields per record is 256, with up to 2 billion per table. The program also supports the ability to query by example, generate sequential numbers, and perform relational links between tables.

$495
Microsoft Corp., Redmond, WA; (206) 882-8080
Circle 1332 on Inquiry Card.

Paradox for Windows 1.0

Paradox for Windows has a new data-access engine, the Borland InterBase Engine, which provides transparent access to Paradox, dBase, and SQL formats, according to Borland. Forms, reports, table

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viewers, queries, and other graphical components are included with Paradox for Windows—components that are part of Borland's Object Component Architecture, or BOCA.

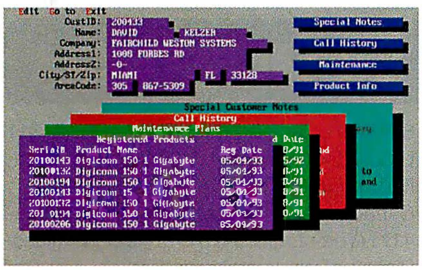
Paradox for Windows includes a set of data integrity rules that you can create in a visual manner. The data-integrity rules are stored within the tables, so all forms, reports, table views, queries, and applications abide by the rules. In addition, any application that uses the Borland InterBase Engine also abides by the data-integrity rules. Other features of Paradox for Windows include secondary indexes, domain integrity, linked cursors, and network support.

Paradox for Windows 1.0 supports DDE and can serve as an OLE client. The database supports up to 255 fields per record and up to 2 billion records per table. To run Paradox you need Windows 3.1 or higher and at least 4 MB of RAM.

$795
Borland International, Inc., Scotts Valley, CA; (408) 438-8400
Circle 1333 on Inquiry Card.

R:Base 4.5 for DOS, Windows, and OS/2

R:Base is a relational database for DOS, Windows, and OS/2 with an interactive debugger. It has ANSI Level-2 SQL built in, along with a menu-driven interface. Microrim reports that improvements in version 4.5 include better speed and per-



formance as a result of a new data indexing system, a smarter query optimizer, and other enhancements.

With R:Base 4.5 you can do full-text data indexes, multicolumn indexes, index-only retrieval, and like-predicate indexes. Security features are also increased with version 4.5 because now you can specify your own data integrity constraints in the SQL create table command.

The R:Base LAN Pack supports up to five additional users on any NetBIOS-compatible network. An R:Base SQL Engine for Windows and DOS is also included, along with numerous utilities.

$795
Microrim, Bellevue, WA; (206) 649-9500; fax: (206) 746-9350
Circle 1334 on Inquiry Card.

Superbase 2.0

Superbase 2.0 relational database for Windows has new visual development tools, including an icon-driven query-by-example interface, a report generator, and a report designer. An Icon Bar lets you switch between open files, indexes, and views, including an editable spreadsheet-style table view. The SuperBasic Language is similar to Microsoft's Visual Basic, according to Software Publishing, and it comes with a debugger.

Version 2.0 supports OLE (client), DDE, and DLL. The database supports several database servers—Oracle, Sybase, XDB, SQL Server, and more. It also supports NetWare, Microsoft LAN Manager, Vines, and 3+Open network operating systems. File formats imported include ASCII, dBase, Lotus 1-2-3, Paradox, and Excel. The number of files per record is limited only by memory, and you can have up to 1 billion records per table. Superbase 2.0 offers data-integrity checking.

$795
Software Publishing Corp., Santa Clara, CA; (408) 988-7518
Circle 1335 on Inquiry Card.

buttonFile

Buttonware's buttonFile is a flat-file database that lets you store names, company names, phone numbers, and contacts on over a dozen predefined card decks. You can customize the card decks, and you can print the data on over 100 predefined forms. The database can import and export from ASCII, dBase, WordPerfect, and from other ButtonWare products.

Other features include password protection and encryption, auto-dial of any phone number on a card, and the ability to sort data in any order (up to three levels). To run buttonFile you need 1 MB of RAM.

$89.95
ButtonWare, Bellevue, WA; (206) 454-0479
Circle 1336 on Inquiry Card.

Acumate for OS/2

Kenan Technologies' multidimensional database for OS/2 has the ability to integrate data from multiple sources with its dynamic SQL links to relational databases. According to the company, Acumate combines the power of a decision support system with the ease of use of an executive information system.

With client/server capabilities added to Acumate, you have the ability to tap into relational databases; the open API lets Acumate feed data to clients on the other end. The database also includes built-in business modeling and statistical and forecasting tools.

Acumate supports a variety of server platforms; these include OS/2, Windows NT, DEC VMS, and Ultrix. Acumate also supports several client platforms, including Lotus Improv, Excel, DECwindows, X Window/Motif, and OS/2 Presentation Manager.

Licenses begin at $4500.
Kenan Technologies, Cambridge, MA; (617) 225-2224; fax: (617) 225-2220
Circle 1337 on Inquiry Card.

Ontos 2.2

Ontos 2.2 is a distributed object database management system for OS/2 that lets you develop applications for use in areas such as CAD, telecommunications, network management, multimedia, and financial modeling.

Ontos comes with Ontos DB, a data dictionary, which includes the database schema stored in the database as objects. The schema is accessible to all applications and tools that interact with the database. Developers can create, access, and modify the database schema at run time, enabling the construction of schema-driven tools such as GUI generators. Ontos DB also offers concurrency control options including pessimistic, optimistic, and time-based models.

Ontos DB provides three storage managers within the single database system. The storage managers are implemented as object classes, so each class is optimized for a different set of performance and functionality trade-offs.

According to Ontos, Ontos DB uses a distributed client/server model, supporting multiple clients attached to a server and multiple servers managing physical

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Santa Ana, CA 92704

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Circle 346 on Inquiry Card (RESELLERS: 347).

databases. Ontos 2.2 runs on OS/2 as well as Unix workstations.

Call company for prices.
Ontos, Inc., Burlington, MA; (617) 272-7110; fax: (617) 272-8101
Circle 1338 on Inquiry Card.

SPREADSHEETS

CA-Compete 5.0 for Windows and OS/2

CA-Compete 5.0 is a multidimensional modeling, data-analysis, and reporting tool for Windows and OS/2. New features in version 5.0 include integrated charting; a configurable toolbar and model bar; multiple open models, views, and sheets; user-defined styles; advanced linking; and print preview with zoom.

The spreadsheets created with CA-Compete can be linked using sheet/model, model/sheet, model/model, and sheet/sheet interdocument linking. Analysis tools include forecast, allocate, curve building, audit trail, goal seek, and data table. You can construct, manipulate, and present multidimensional models along with linked two-dimensional spreadsheets and integrated charts. You can explore the relationships among up to 12 dimensions of your data and the impact that change in one can have in the others. You can also drag and drop a column label to transpose the rows and columns.

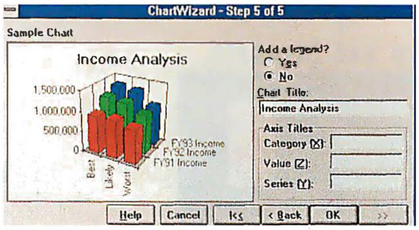
You can access over 150 database, date/time, financial, informational, logical, lookup, mathematical, statistical, string, and trigonometric functions. The program also lets you define your models using natural language. CA-Compete supports DDE and DLL. It also will work with other data formats, including CA-SuperCalc, Lotus 1-2-3, Excel, Xbase, and ASCII.

$495
Computer Associates International, Inc., Islandia, NY; (516) 342-5224
Circle 1339 on Inquiry Card.

Excel

Microsoft says that by using the auto-format and drag-and-drop capabilities in the newest versions of Excel, you can create a basic worksheet in 60 seconds. In addition to analytical tools, chart and reporting tools, and technology that lets you run macros from Lotus 1-2-3 unmodified, Excel 4.0 has Wizards, which are on-line assistants that walk you through complex tasks. Shortcut menus pop up with context-sensitive and most-used commands. Task-oriented toolbars offer one-click access to the most frequently used commands.

A Scenario Manager lets you create and save multiple what-if scenarios in a single file and then create a separate summary report of them. Workbooks let you manipulate and store groups of files. And the Analysis ToolPak adds 140 functions, including complex number support and se-



curities calculations and 20 new procedures.

With the brand-new Excel 5.0, Microsoft has added Improv-like data modeling, 3-D worksheets, OLE 2.0 capabilities (client and server), and Visual Basic, Applications.

$495
Microsoft Corp., Redmond, WA; (206) 936-3227, fax: (206) 936-7329
Circle 1340 on Inquiry Card.

Improv for Windows 2.1

Lotus says Improv 2.1 simplifies complex analytical tasks by letting users change the perspective views of their data. With the ability to examine data in a variety of ways and use English-language formulas, Improv is suited for users who need to arrange data into different layouts, reuse and maintain spreadsheets, and extend an analysis to incorporate new data or factors.

The latest version of Improv offers network-ready installation, external data access capabilities, and compatibility with the WK4 file format for the new 1-2-3 release 4. The new Improv also works with Lotus Notes.

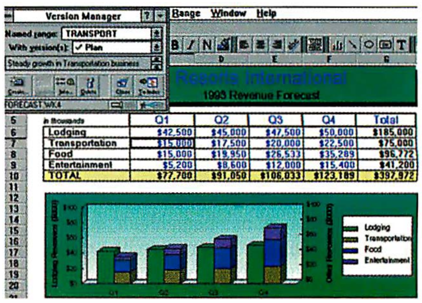
Familiar spreadsheet components such as cells and formulas, what-if analysis, and business graphics are all elements of Improv. Dynamic views give you control over the arrangement of categories of data along the rows, columns, and pages. You can use the mouse to drag and drop categories, and you can display, analyze, and manipulate up to 12 categories of data within a worksheet all at one time, according to Lotus.

Improv for Windows offers English-language explanations of the spreadsheet logic. Chart types include 3-D bar, stack, line, bar pie, scatter, and bar graphs. Data and graphs are dynamically linked, so any changes you make in a worksheet are reflected in the associated graph. InfoBox is a feature that lets you change the look of a spreadsheet. It's a flowing, modeless panel that lets you set the style of any object or chart.

$495
Lotus Development Corp., Cambridge, MA; (617) 577-8500
Circle 1341 on Inquiry Card.

Lotus 1-2-3 Release 4 for Windows and 1-2-3 for OS/2 Release 2.0

Lotus says this new version of Lotus 1-2-3 offers a simplified, context-sensitive interface. Menus are shown according to the task at hand. The program has a version manager that tracks changes in spreadsheets shared among workgroups. It also includes a data-query tool. Other features include "One-Step Charting," customizable fill-by-example, worksheet tabs, and in-cell editing.



The new cell engine results in improved recalculation performance, according to Lotus. Release 4 for Windows includes more than 250 macro commands. You can create on-sheet buttons to run macro programs and to build custom applications with prebuilt dialog boxes. For access to databases, release 4 ships with the most common database drivers, including dBase, Paradox, SQL Server, and OS/2 Data Manager. Release 4 supports OLE, DDE, ODBC (Open Database Connectivity),

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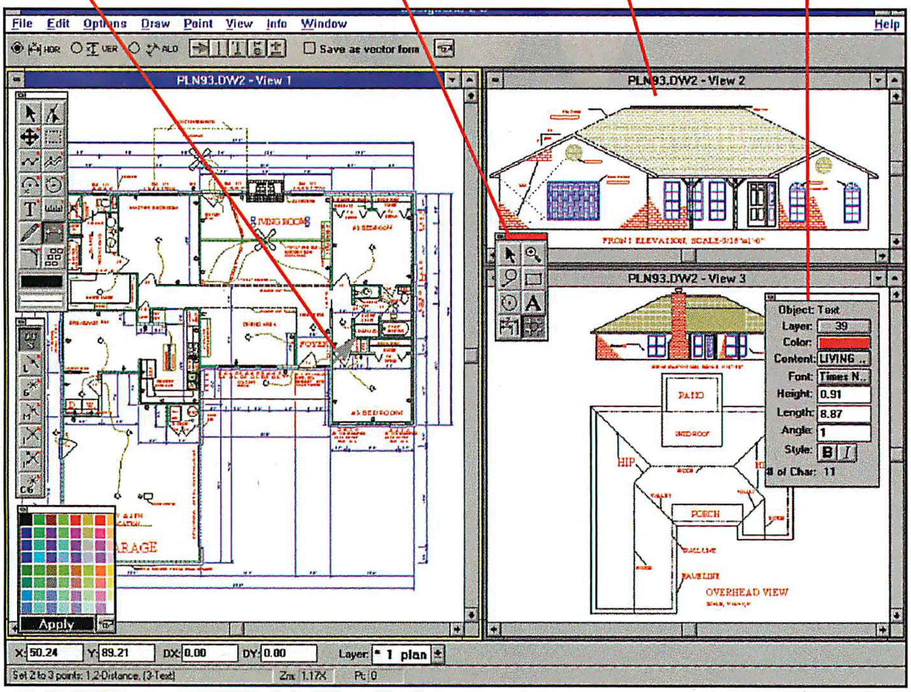
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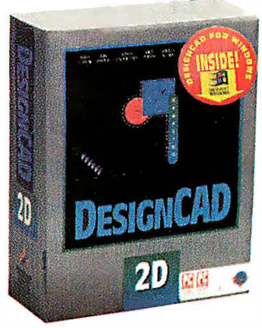
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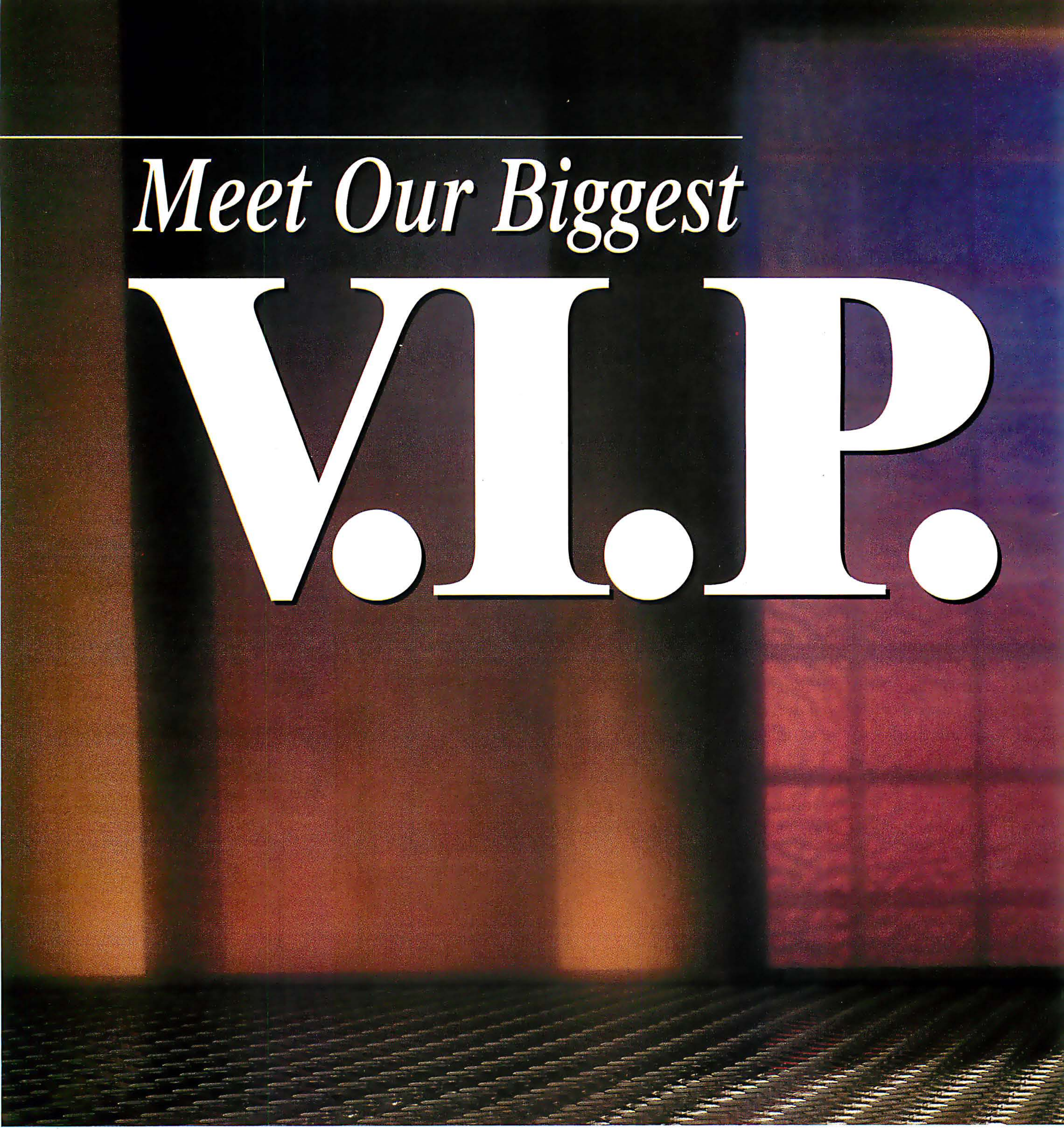
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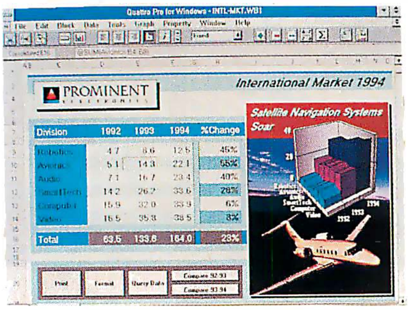
Lotus 1-2-3 for OS/2 Release 2.0 offers customizable, context-sensitive Smart Icons, menus, and dialog boxes to build spreadsheet applications that use scroll bars, radio buttons, and check boxes. It performs adjust-to-page printing to resize worksheets and offers you the ability to select "collections" of noncontiguous cell ranges. There's also a C-language interface. Version 2.0 adds Solver and Back-Solver technology to perform optimization analysis, presentation-quality output, database management, and Datalens data access technology.

$495
Lotus Development Corp., Cambridge, MA; (617) 577-8500
Circle 1342 on Inquiry Card.

Quattro Pro for Windows

Borland's Quattro Pro for Windows has two technologies that Borland describes as unique: Spreadsheet Notebooks and Object Inspector menus. Spreadsheet Notebooks are based on the tabbed paper notebook and let you organize spreadsheet data and improve the way you build and manage spreadsheets. Object Inspector menus let you right-click on an object to display a list of options that can be changed for that object.

Other features include a SpeedBar, which provides point-and-click access to



certain features, presentation graphics, access to external databases, and visual application-building tools. SpeedFill determines what information should be placed into a range of cells, based on information you provide.

Quattro Pro for Windows uses Borland's Object Component Architecture, or BOCA, to connect users to dBase and Paradox files. The program also offers query-by-example tools. Other files supported include Quattro Pro for DOS, Excel 3.0 and 4.0, and Lotus 1-2-3. Graphics files supported include BMP, EPS, CGM, PCX, GIF, and TIF.

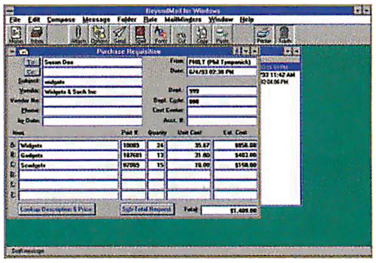
$495
Borland International, Inc., Scotts Valley, CA; (408) 438-8400
Circle 1343 on Inquiry Card.

COMMUNICATIONS

BeyondMail 2.0

Release 2.0 of BeyondMail includes NetWare Global MHS support, shrink-wrapped tools for developing work-flow applications, and cross-platform capabilities.

With NetWare Global MHS support, NetWare users can now use BeyondMail 2.0, and it can be synchronized with NetWare 4.0 NDS. It also provides full-name support for users on MHS 1.5. Beyond



will release Macintosh and Unix versions of BeyondMail later this year, the company reports, and release 2.0 will deliver rules, forms, and work-flow compatibility across all those platforms. Also included with BeyondMail 2.0 is Watermark Software's Explorer Edition, an OLE-based document-imaging program that enables you to embed image thumbnails into messages that recipients can view and annotate.

BeyondMail 2.0 supports OLE and DDE. Database formats supported include dBase, Paradox, FoxPro, Oracle, and Sybase.

$995 for a 10-user license
Beyond, Inc., Cambridge, MA; (617) 621-0095; fax: (617) 621-0096
Circle 1033 on Inquiry Card.

Carbon Copy for Windows 2.0

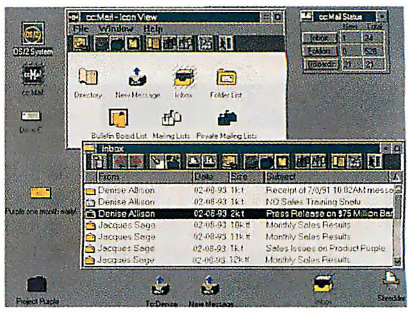
Remote support and access are the primary uses of Carbon Copy for Windows. Version 2.0 supports networks, letting users connected to a NetWare LAN access data and applications on a remote PC or another PC on the network.

Other features of Carbon Copy for Windows 2.0 include drag-and-drop capability, an event log, a file detail option that lets users display filenames only or a combination of names, dates, times, and file attributes. Roving Callback is another new feature, and it lets users specify the number they're calling from. Security is preset on the host PC, preventing unauthorized access and enabling Carbon Copy to call back users at the number they are dialing from. According to Microcom, the Virtual Desktop feature adds ease of use. It enhances the Remote Control utility when two PCs with different screen resolutions communicate. Virtual Desktop displays a scaled-down version of the host screen in a foreground frame, and the guest user can click on a portion of the frame to view the desired area of the host screen. DOS applications can run full screen or in a window. To use the program, you need an IBM AT-compatible modem.

$199 for a two-user license
Microcom, Inc., Norwood, MA; (617) 551-1000; fax: (617) 551-1021
Circle 1034 on Inquiry Card.

cc:Mail 2.0 for Windows and OS/2 Workplace Shell

Version 2.0 of cc:Mail for Windows features a redesigned user interface and new rules and search capabilities. Message handling is automated with the rules in cc:Mail, and as a result, you can instruct the mail system to perform tasks if certain events occur. The rules are dialog driven with pick



lists. The new search capability gives you additional mail management functions.

Other new features include viewers for many spreadsheet applications, the ability to find and replace text, a spelling check-

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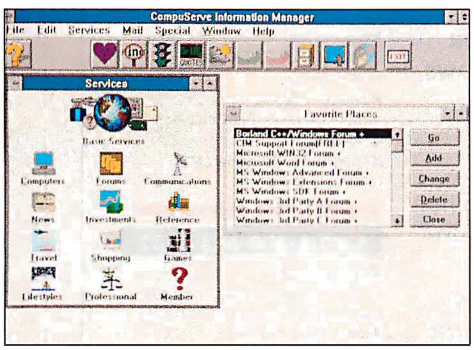
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er, folders for storing messages, and the ability to compress attached files with a user-selectable compression algorithm. In addition, cc:Mail supports DDE and OLE as well as VIM.

Lotus cc:Mail for OS/2 Workplace Shell allows for message processing in the background through OS/2's multithreading and preemptive multitasking capabilities, letting you send and receive mail from other applications. Features such as inboxes, message folders, BBSes, and directories are presented as individual desktop objects. Users can gather E-mail messages together with other items associated with a project by "shadowing" objects in the cc:Mail folder any number of times.

Other features of cc:Mail for OS/2 Workplace Shell include the ability to view faxes and attach graphics and audio files to a message, a draft folder for storing messages in progress, a trash folder for retrieving deleted messages, and the ability to do Boolean searches for filtering messages.

$495
Lotus Development Corp., Cambridge, MA; (617) 577-8500
Circle 1035 on Inquiry Card.

Co/Session 6.01 for Windows

With Co/Session you can operate a remote PC over phone lines, letting you run programs, access data, print reports, and transfer files from one system to the other. Co/Session allows two PC users to work together on the same program because of its dual-screen, dual-keyboard capability. Co/Session's "Intelligent Graphics" technology is responsible for moving the Windows screen information across the phone lines.

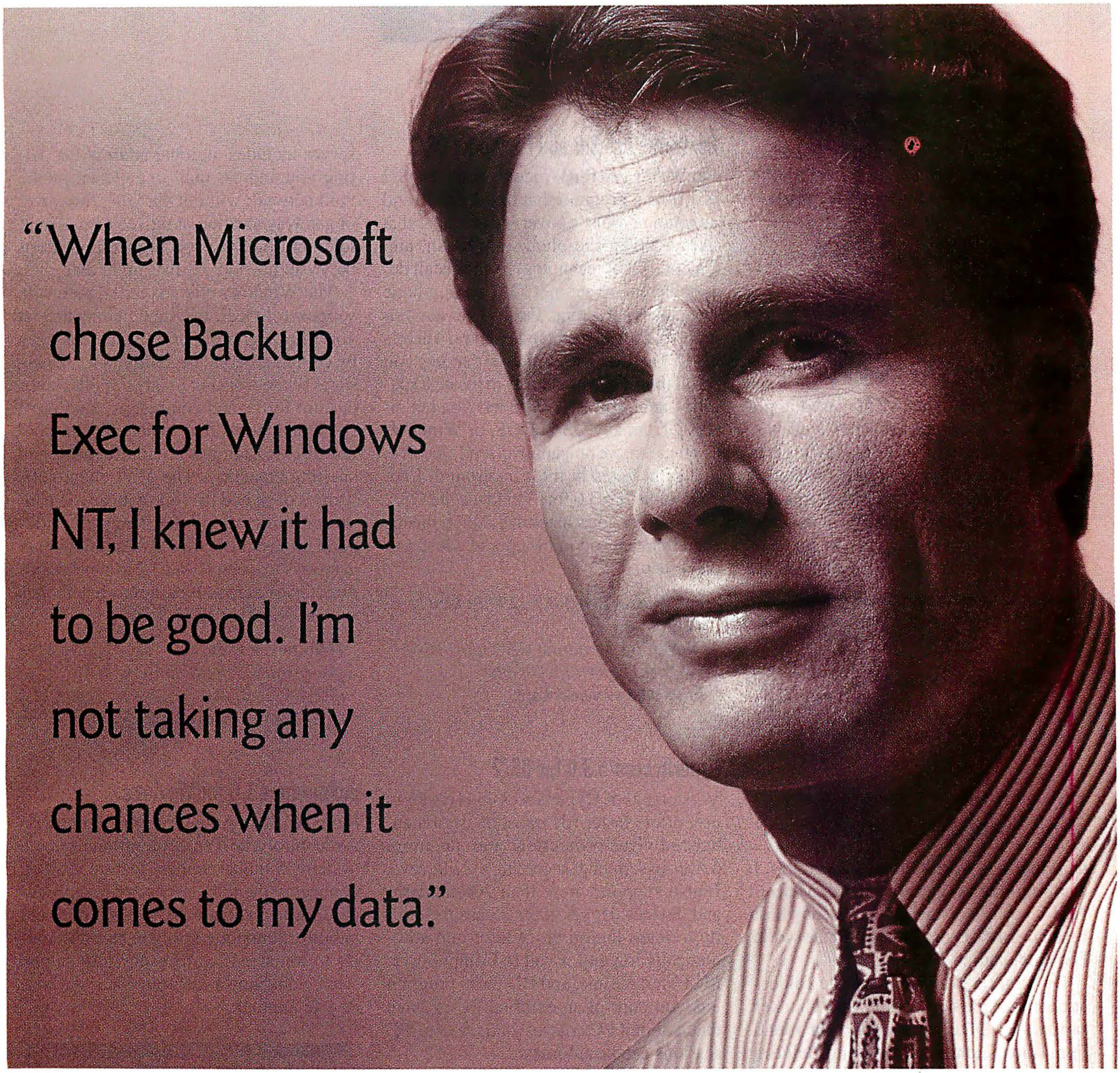
According to Triton, Co/Session allows background file transfers, command-line file transfers, and point-and-shoot file transfers. Security features include multiple passwords, dial back, and data encryption. The program supports all IPX and NetBIOS PC Networks, including Novell, Banyan, 3Com, LANtastic, AT&T StarLAN, and IBM Token Ring. To run Co/Session you need to have 5 KB to 75 KB of RAM on the host and 123 KB of RAM on the guest.

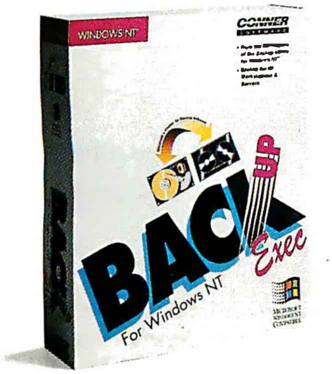
Other features include keyboard chat, a billing log, session recording, on-line configuration changes, and the ability to toggle between voice and data connections while still connected.

$195
Triton Technologies, Inc., Iselin, NJ; (908) 855-9440
Circle 1036 on Inquiry Card.

Crosstalk for Windows

The Windows version of this veteran communications program offers terminal emulations and file transfer protocols, including ZMODEM. It also supports DDE and features a macro ability that lets you assign multistep activities to special on-screen objects on the QuickPad. You can perform regularly executed tasks via icons in the QuickBar, and you can mark text on-screen for copying to other applica-





Microsoft demanded an innovative backup utility for Windows NT. That's why they turned to Conner Software. Now you can protect your data with a full-featured version of that same software: Backup Exec for Windows NT. It's easy to use because it matches the NT interface exactly. Its simple installation program will have you up and running in no time. You can set it to automatically backup, even when nobody's around. Our disk grooming feature will allow you to move inactive files to tape, freeing up valuable disk space. And if you know how to use File Manager, you'll know how to use Backup Exec. Plus, it uses the Microsoft Tape Format (MTF), which enables you to exchange tapes with any NT user or system. If you don't want to take chances with your data, it's important to protect it with Backup Exec.

To order Backup Exec for Windows NT, or any of Conner's other software products, call 1-800-4NT-BKUP.

MICROSOFT. WINDOWS NT. COMPATIBLE

CONNER
The Storage Answer

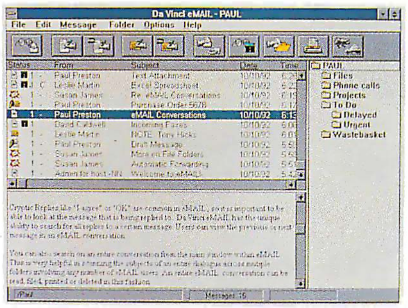
Circle 388 on Inquiry Card (RESELLERS: 389).

tions. The script language is based on CASL and lets you create scripts that include dialog boxes for repetitive tasks.

$195
Digital Communications Associates, Inc., Alpharetta, GA; (404) 442-4000
Circle 1037 on Inquiry Card.

Da Vinci eMail 2.5 for Windows

Da Vinci eMail is an MHS-based application that is optimized for Novell NetWare and works on any file-sharing network, Da Vinci Systems says. When run with NetWare, Da Vinci eMail ties into NetWare's security functions and directories. It provides native support for Novell's SMF (Simple Message Format) standard and NetWare Global Messaging. It also requires no gateway. With MHS or NGM, you can connect to almost any host-based or LAN E-mail system in the world, Da Vinci claims.



Da Vinci eMail includes file folders, attachment viewers, a spelling checker, support for DDE, and support for sound. Functions such as adding and deleting users have been made into one-step operations. With version 2.5, eMail supports NGM's new SMF-71 transport standard, which Da Vinci says increases the interoperability between other front-end E-mail systems that don't have MHS. Version 2.5 is also integrated with NetWare 4.0, which lets you tie in with 4.0's NetWare Directory service to synchronize user names over the network. Also provided with version 2.5 of eMail are two names-synchronization solutions: Address Book Synchronization and Names Services. Both run as MHS gateways on dedicated workstations.

$499
Da Vinci Systems Corp., Raleigh, NC; (919) 881-4320
Circle 1038 on Inquiry Card.

FaxWorks Pro 3.0 and FaxWorks OS/2

FaxWorks Pro for Windows and for OS/2 is a faxing program that has drawing and annotating tools, a cover-sheet maker that uses a fill-in-the-blanks approach, and Calera's OCR technology. AutoInstall detects hardware setup, COM ports, phone line, and baud setting. FaxTracker lets you archive, find, log, and index faxes. There's also a Fax Log with a viewer that lets you scroll through logged faxes to locate a specific one. FaxWorks OS/2 lets you fax directly from any OS/2, DOS, or Windows applications. You can also send, receive, and print faxes in the background. Like FaxWorks Pro 3.0 for Windows, the OS/2 version lets you customize cover sheets, scan images, and mark up and edit faxes on-screen.

FaxWorks Pro 3.0, $129.99; OS/2, $149
SofNet, Inc., Atlanta, GA; (404) 984-8088; fax: (404) 984-9956
Circle 1039 on Inquiry Card.

HyperAccess/5 3.0 for OS/2

Version 3.0 of HyperAccess/5 is easier to use, offers faster file transfers, sports enhanced virus protection, and has more powerful scripting, according to Hilgraeve. It also supports more than 200 modems and devices. HyperAccess/5 has the ability to learn log-on procedures and automatically log on for you to CompuServe, MCI Mail, GEnie, and BIX. The program lets you control an external PC or have that external PC control yours. PC-to-PC sessions can be automated.

File transfer protocols supported include YMODEM, XMODEM, ZMODEM, and ASCII. HyperAccess/5 can also detect viruses within compressed ZIP files, Hilgraeve says, and has the ability to decompress ZIP files on the fly as you download. The editor has a spelling checker, search-and-replace functions, and split-window capability.

$199
Hilgraeve, Monroe, MI; (313) 243-0576; fax: (313) 243-0645
Circle 1040 on Inquiry Card.

Mail 3.2

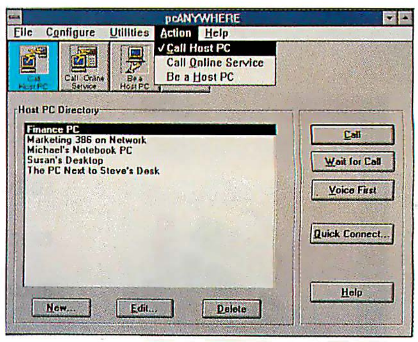
Mail 3.2 has additions to the Microsoft Mail server and DOS-based clients, along with support for MAPI. The new mail server includes a global address list, letting you address mail to any user on the mail network without knowing the server or gateway location of the recipient. Fault-tolerant directory synchronization keeps the system's address lists up to date.

The Windows client is redesigned with support for OLE, message finders that let you filter incoming or existing messages by certain criteria, the ability to send messages while working in other applications, custom forms and commands, intelligent file attachments that recipients can double-click to launch an application, and spelling checking. The Mail client software is designed to work with any E-mail server using a modular, transport-independent architecture. Also available are gateways to extend Mail 3.2 to synchronize directories across messaging backbones such as X.400 or IBM SNA.

$695 per server
Microsoft Corp., Redmond, WA; (206) 882-8080
Circle 1041 on Inquiry Card.

pcAnywhere 1.0 for Windows

Symantec's pcAnywhere lets you access and control a host computer from a remote system. A quick-connect feature lets you connect to the remote system quickly, according to Symantec. Drag-and-drop capability is supported, so you have the ability to transfer files from the host in one step by dragging a file from one menu window to another.



Terminal emulations include ANSI, DEC, IBM, and Data General. File transfer protocols include ASCII, XMODEM, YMODEM, and Kermit. The program also features data compression and error correction along with a script editor and language that lets you automate remote and general communications. Security features

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PC MAGAZINE EDITORS' CHOICE
May 11, 1993
Systat5.01/Windows

NEW
SYSTAT® for WINDOWS

#1 for DOS and Windows

Rated "the best general-purpose statistics program" for the PC by *Software Digest®*, SYSTAT for DOS is now joined by SYSTAT for Windows. This addition to the SYSTAT family takes full advantage of Windows, with pull-down menus, dialog boxes, sizable windows, and the ease of use you expect in a Windows package.

SYSTAT for Windows runs in standard and 386 enhanced modes and can take advantage of Windows advanced memory management. No matter how large or complex your analysis is, you can use SYSTAT.

SYSTAT delivers a balance of power and simplicity. It lets you analyze and manipulate data with a comprehensive range of advanced statistical procedures, and present your results with stunning graphics.

Just point and click

SYSTAT is a full-fledged Windows application. Just point and click. SYSTAT's QuickStat™ buttons give you simple, single-click shortcuts to common statistical analyses.

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No other statistical or graphics package can produce all the scientific and technical graphs that SYSTAT can–nor surpass its ease of use. Graphics capabilities include:

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- stem-and-leaf diagrams
- pie charts
- scatterplot matrices
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- contour plots
- control charts
- maps with geographic projections
- Chernoff faces
- complete color spectrum
- log and power scales
- confidence intervals and ellipses
- linear, quadratic, step, spline, polynomial, LOWESS, exponential, and log smoothing

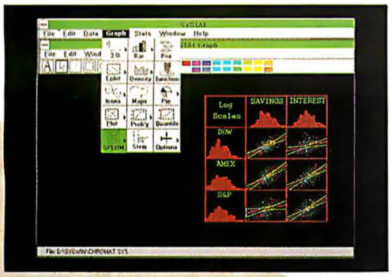
A compatible family of products

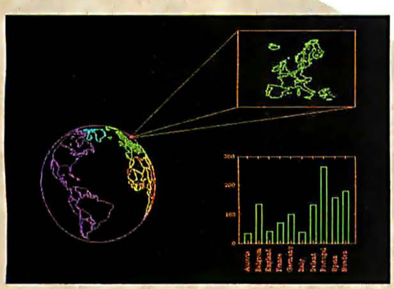
Whichever you choose–SYSTAT for Windows, SYSTAT for DOS or both–you'll enjoy the most powerful statistics and scientific graphics software available for the PC.

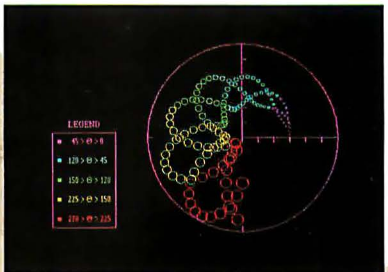
For more information, special offers for current users, and demo disks, call:

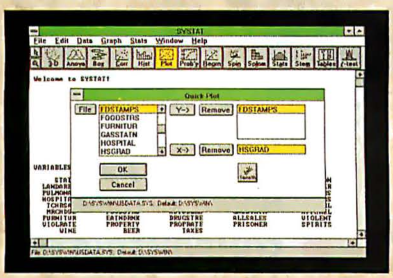
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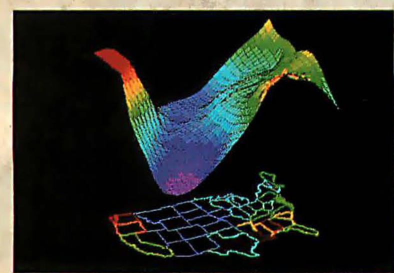
For Windows circle 330,
For IBM/DOS circle 331.

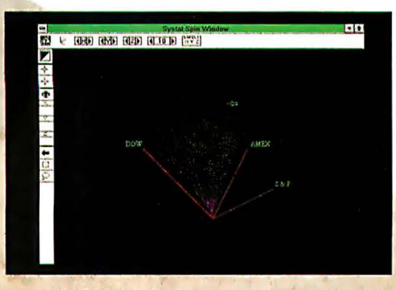












For more information call or write: **SYSTAT, Inc.**, 1800 Sherman Avenue, Evanston, Illinois 60201-3793. Tel: 708.864.5670, Fax: 708.492.3567

SYSTAT®

Australia: Hearne Marketing 61.3.8661766, **BeNeLux:** Oasis 31.3402.66336, **Denmark:** Agrolab 45.64.406575, **France:** Deltasoft 33.76.418508, **Germany:** STATCON 49.55.4272075, **Italy:** PiSoft 39.587.213640, **Japan:** HuLinks 81.33.5902311, **New Zealand:** Hoare & Assoc. 64.78.562675, **Poland:** COMPANION 48.12.360791, **Spain:** AddLink 34.3.4157268, **Switzerland:** F & P 41. 31. 3125151, **SYSTAT UK:** 44.81.4620093

include password protection, screen blanking, keyboard locking, remote callback, and notification during access.

$199
Symantec Corp., Cupertino, CA; (408) 253-9600; fax: (408) 252-4694
Circle 1042 on Inquiry Card.

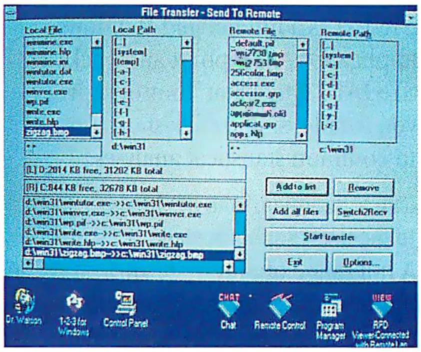
Procomm Plus for Windows 1.0

The Windows version of this popular package provides 34 terminal emulations and 10 error-correcting file transfer protocols, including ZMODEM. There's also an automated dialing directory, a scripting language, support for DDE, a graphics dialog-box editor, keyboard remapping, and a GIF utility for viewing graphics files as you download them.

$179
Datastorm Technologies, Columbia, MO; (314) 443-3282; fax: (314) 875-0595
Circle 1043 on Inquiry Card.

Remotely Possible/LAN 1.0 and Dial 2.1b for Windows and Windows NT

Remotely Possible/LAN for Windows lets you control another PC on your Novell, IPX, NetBIOS, or Windows for Workgroups networks. It offers you remote con-



trol, file transfer, and chat capabilities. Remotely Possible/Dial 2.1b also lets you operate a remote Windows PC. It offers remote control, file transfer, and chat. A version of both products was recently announced for Windows NT.

The Remotely Possible products provide full video translation and support for Super VGA displays with 24-bit true-color operation, according to Avalan. Version 2.1b of Dial has a video-panning feature as well. This lets you see the entire host screen even if it's running at a higher resolution than the viewer. By moving the cursor, you can see information outside the viewing area.

Security features include optional log-ins with multilevel password and user IDs, modem dialback, multiple access levels, and a Windows icon that shows the name of a remote user when connected.

$199 for host and viewer for LAN and Dial; $499 for NT version
Avalan Technology, Holliston, MA; (508) 429-6482; fax: (508) 429-3179
Circle 1044 on Inquiry Card.

Rumba for Windows and OS/2

Rumba brings IBM mainframe applications to your PC desktop. The Windows and OS/2 versions look and operate the

Circle 387 on Inquiry Card.

same, according to Wall Data. The Windows version lets you work with the mainframe applications as if you were working in Windows, and the OS/2 version is fully integrated with IBM OS/2 Presentation Manager, Wall Data says.

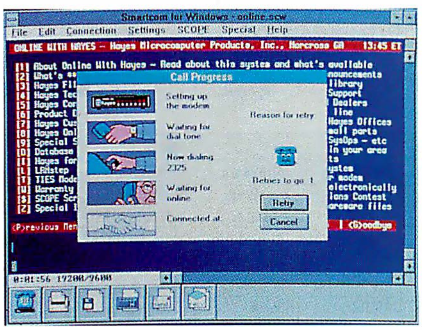
You can start as many mainframe sessions as your PC memory or interface will allow. Then you can change display colors, customize keyboards, copy and paste information between PC and mainframe applications, print host documents on local printers, and more.

Wall Data says that Rumba supports all major networks, gateways, and communications interfaces. To run Rumba for the Mainframe under Windows, you need Windows 3.0 or higher, and you need OS/2 2.0 or higher for the OS/2 version.

$495
Wall Data, Redmond, WA; (206) 883-4777
Circle 1045 on Inquiry Card.

Smartcom for Windows 1.0

Smartcom for Windows is a communications program from Hayes Microcomputer Products that has macro capability, a scripting language, an editor, DDE support, and more. The macro capability, called Smart Buttons, lets you keep common commands and scripts available at the click of a button. You can import Windows icons to create Smart Buttons, or you can choose from the bundled icons.



The Scope scripting language lets you automate tasks and create interface-driven scripts.

The package lets you start communications sessions by clicking the mouse or dragging and dropping communications documents onto the program's icon. File transfer protocols supported include XMODEM, YMODEM, and ZMODEM. Smartcom for Windows also supports background communications and file transfers. With additional copies of the program, you can run multiple communications sessions simultaneously. Smartcom for Windows is compatible with NetBIOS networks.

$149
Hayes Microcomputer Products, Inc., Norcross, GA; (404) 840-9200; fax: (404) 441-1213
Circle 1046 on Inquiry Card.

Terminal Plus with FAXit

FutureSoft Engineering's Terminal Plus with FAXit is communications and fax software that offers fax functions, multimedia extensions, file transfer protocols, terminal emulations, and preconfigured settings for more than 80 modems. Using Terminal Plus with FAXit, you can send faxes from any Windows application and view or read faxes without printing. The multimedia extension lets you attach voice and sound cues to different communications events.

$195
FutureSoft Engineering, Houston, TX; (713) 496-9400; fax: (713) 496-1090
Circle 1047 on Inquiry Card.

WinBeep

This PC-to-beeper communications software lets you send written messages to people with alphanumeric pagers. The size of the message is determined by the receiving pager, or paging device, which can be as much as 6000 characters, or about three pages of information. To use WinBeep, you click on a name display, type your message, and click on Send. Your modem transmits the message by pager transmission networks to the pager, and the recipient is audibly or visually alerted.

WinBeep is DDE-aware, so you can beeper-enable Windows applications. You can also trigger WinBeep to send messages from within the applications at prescheduled times or in response to certain PC events.

$149
Fourth Wave Technologies, Inc., Troy, MI; (313) 362-2288
Circle 1048 on Inquiry Card.

WinFax Pro 3.0

The WinFax line of fax software lets you send faxes directly from Windows and receive faxes directly onto your hard drive. WinFax Pro 3.0 adds annotation, OCR, fax document management, an advanced phone book, a cover-page designer, image processing, and scanner support. WinFax Pro also includes a TSR program that enables you to receive faxes while you're working in DOS.

With the annotation and drawing tools, you can mark up faxes with text, or you can use the object-based drawing tools to add lines, circles, squares, boxes, ellipses, and freehand sketches. You can also import graphics into 3.0 and merge annotations onto the fax image itself. With OCR capability, you can convert faxes into an editable format for word processors and spreadsheets. WinFax Pro uses AnyFax, OCR technology developed by Caere. The cover-page designer lets you choose from a library of covers or create your own.

$129
Delrina Corp., San Jose, CA; (800) 268-6082
Circle 1049 on Inquiry Card.

GRAPHICS

CA-Cricket Image for Windows

CA-Cricket Image lets you manipulate, convert, and compress images, as well as prepare color separations. With user-definable controls and interactive color reduction, you can control the levels and response curves of the individual colors. If it's too sharp, a picture can be softened, and if it's too blurry, it can be sharpened. Noise generated in the scanning process can also be removed, according to Computer Associates. Special effects you can apply to an image include oil painting (which makes a photo appear as if it were brush-stroked), colorized embossing, posterizing, and combined effects. File translations include TGA, PIX, WIN, BPX, BMP, TIF, PCX, GIF, CVP, and JPG.

$295
Computer Associates International, Inc., Islandia, NY; (516) 342-5224, (800) 225-5224; fax: (516) 342-5329
Circle 1050 on Inquiry Card.

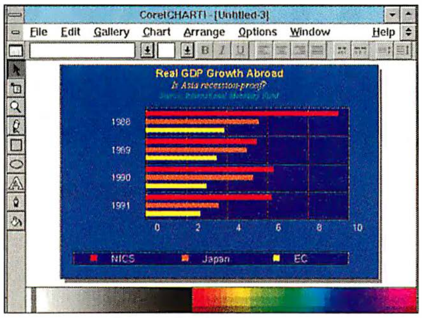
CA-Cricket Paint for Windows

CA-Cricket Paint gives you the tools to draw lines or shapes, print text, paint textures, airbrush shadows, copy an image, or blur a region. You can use Undo with a brush or airbrush. You can paint with color; with linear, radial, or two-way color gradients; or with clones from another or the same image. You can also output to any Windows raster device in color, gray scale, black and white, PostScript, or non-PostScript, according to Computer Associates. The program works on 24-bit color or 8-bit gray-scale images.

$595
Computer Associates International, Inc., Islandia, NY; (516) 342-5224, (800) 225-5224; fax: (516) 342-5329
Circle 1051 on Inquiry Card.

CorelDraw 4.0

The latest version of this all-in-one graphics kit from Corel incorporates seven modules: Draw, Photo-Paint, Chart, Show,



Move, Trace, and Mosaic. Move is the newest module and lets you create 2-D animations with sounds.

Version 4 of CorelDraw also offers libraries of clip art, animation, and sounds, as well as 750 fonts in TrueType and Type 1 formats. The collection includes more than 18,000 images and more than 125 animations.

The product imports and exports 22 graphics formats, including JPEG, Kodak Photo CD, and Micrografx DRW files.

Fifteen additional filters are provided for importing text from word processors and spreadsheets. CorelDraw supports OLE and all major networks, including Novell NetWare, NetWare Light, and LANtastic.

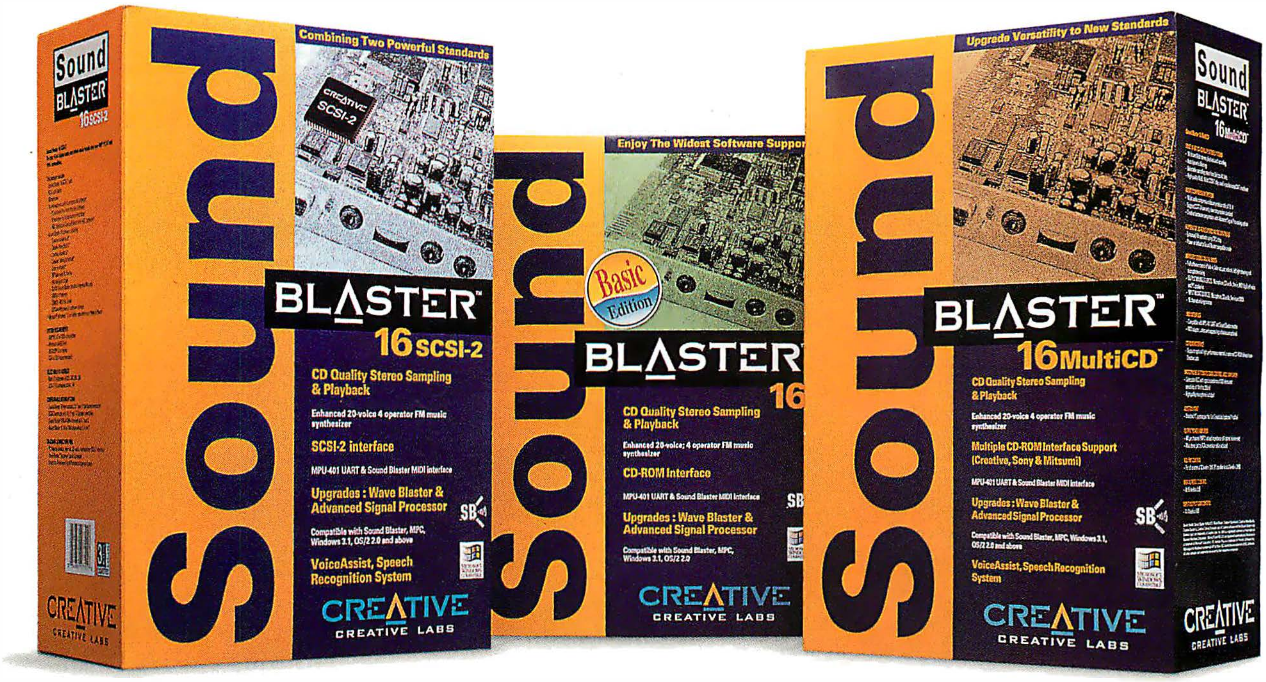
$595
Corel Corp., Ottawa, Ontario, Canada; (613) 728-8200; fax: (613) 728-9790
Circle 1052 on Inquiry Card.

Designer 4.0 for Windows

The newest Windows version of this illustration program includes 3-D drawing, editing to 1 micron, a streamlined interface with interactive tool ribbon and hint line, and color-separation capabilities (spot and process color).

Designer 4.0's text-handling features include the ability to edit transformed text and the ability to flow text in and around irregular shapes. The program comes with a clip-art library of more than 13,000 images. And it imports and exports most major graphics files as well as offering support for the TWAIN scanner standard.

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	Sound Blaster 16 Basic Edition	Sound Blaster 16 MultiCD	Sound Blaster 16 SCSI-2
Format	16-bit stereo	16-bit stereo	16-bit stereo
Advanced Signal Processing Upgradability	Yes	Yes	Yes
Wave Blaster Upgradability	Yes	Yes	
CD-ROM Compatibility	Creative Labs/ Panasonic	Sony, Mitsumi, Creative Labs/ Panasonic	Any SCSI or SCSI-2
Bundled Hardware		Microphone	Microphone
Bundled Software	Monologue for Windows Creative WaveStudio Creative Soundo'LE Creative Talking Scheduler Creative Mosaic	Software Toolworks Multimedia Encycl. PC Animate Plus Monologue for Windows Creative WaveStudio Creative Soundo'LE Creative Talking Scheduler Creative Mosaic Creative VoiceAssist	Software Toolworks Multimedia Encycl. PC Animate Plus Monologue for Windows Creative WaveStudio Creative Soundo'LE Creative Talking Scheduler Creative Mosaic Creative VoiceAssist
Suggested Retail	$199.95	$249.95	$279.95
W/Advanced Signal Processing Upgrade	Not applicable	$299.95	$329.95

Sound BLASTER™ CREATIVE™
CREATIVE LABS, INC.

*SRP. Note: Sound Blaster 16 MCD works with Sony CDU31A and CD31A-003; Mitsumi CRMC-LU005s, -FX001 and -FX001D; and Panasonic CDR-523 and -563.

Circle 343 on Inquiry Card.

The product's target audience includes technical illustrators, graphic artists, and professional designers. Designer 4.0 supports OLE.

$695
Micrografx, Inc., Richardson, TX; (214) 234-6018; fax: (214) 234-2410
Circle 1053 on Inquiry Card.

Draw 3.0 for Windows and Draw for OS/2

Draw is an entry-level drawing product available for Windows and OS/2. The new Windows version includes OLE support plus 32 resident TrueType fonts. The OLE support lets you link or embed a drawing in a document created with a word processing or desktop publishing program. A TrueType convert-to-curve feature lets you convert fonts to curves for editing. You can type in text, convert it to curves, and treat text characters as line art.

$149.95
Micrografx, Inc., Richardson, TX; (214) 234-6018; fax: (214) 234-2410
Circle 1054 on Inquiry Card.

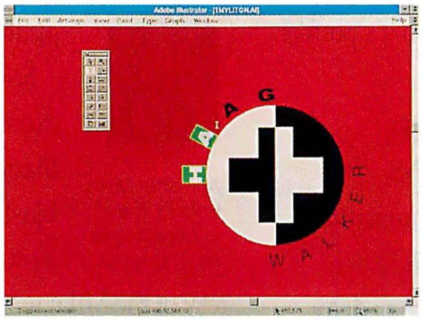
Illustrator 4.0

Adobe Illustrator for Windows is a professional illustration program. Release 4.0 includes Adobe Type Manager, 40 Adobe Type 1 scalable fonts, the Adobe TypeAlign type-manipulation program, color-separation software, and a selection of patterns, textures, symbols, and borders. Adobe says that users of Illustrator for Windows can exchange files with users of Illustrator for the Mac and Next with full compatibility.

Using Illustrator, you can sketch freehand, trace over scans, or enter object dimensions for automatic creation. You can also add and select points on curves, lines, and objects.

Text-handling features enable you to place text on a line or curve, even within an object. You can position text in a defined block of any shape, according to Adobe, and link it to other text blocks or wrap it around any object. Illustrator supports 16- and 24-bit color and lets you select from more than 16.7 million colors on-screen.

New features in Adobe Illustrator for Windows 4.0 include editing in preview mode, on-screen text entry and manipulation, better control over artwork with marquee zoom, a new graphing tool, enhanced



color features, and context-sensitive help.

Registered Adobe Illustrator for Windows customers can upgrade to version 4.0 for $99 and receive a free copy of Adobe Streamline 3.0 for Windows.

$695
Adobe Systems, Inc., Mountain View, CA; (415) 961-4400
Circle 1056 on Inquiry Card.

ImageWizard

ImageWizard 1.0 is an object-oriented image-editing program for Windows. It gives you tools for manipulating photographs, Photo CD images, clip art, and bit-mapped pictures.

The program lets you create and layer multiple independent objects. Object effects include trim, untrim, blend, rotate, size, distort, auto-antialias, tint, vary transparency, recolor, flip, posterize, stamp, knit, and clone. Brush effects include object textures, stamp, stamp recolor, shuffle, smudge, blur, sharpen, gray scale, and posterize. ImageWizard supports the TWAIN scanner standard and OLE. It also supports all the major graphics formats.

$199
ImageWare Software, Inc., San Diego, CA; (619) 457-8600; fax: (619) 457-8290
Circle 1057 on Inquiry Card.

Picture Publisher 4.0

Micrografx calls Picture Publisher the desktop darkroom for Windows. The program is geared toward sophisticated computer users who aren't necessarily graphics professionals. The new version of the image editor includes Object Layers, which allows you to edit and move objects that you've pasted in. FastBits is another new feature, and it lets you quickly open just the section of the picture you want to work on rather than loading the whole image into memory.

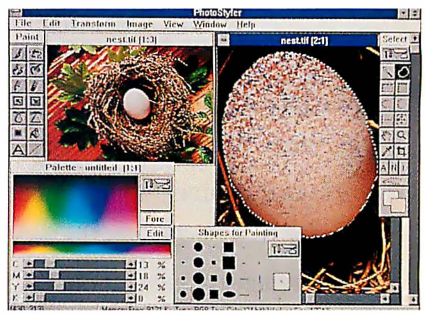
The ImageBrowser feature provides thumbnails of images that users can open and save. Further enhancements include searches based on keywords and filenames.

Other features of Picture Publisher include masking ability, editing and retouching tools, special effects and filters, and a range of output capabilities. Version 4.0 also has some Painter-like tools, such as crayons, oil paints, and markers. Picture Publisher is OLE 1.0–aware and supports the TWAIN scanner standard and Kodak Photo CD. It lets you import and export all the major file formats.

$595
Micrografx, Inc., Richardson, TX; (214) 234-6018; fax: (214) 234-2410
Circle 1058 on Inquiry Card.

PhotoStyler 1.1

PhotoStyler is a full-color image-processing program for Windows. It lets you scan, enhance, compose, retouch, and print 24-bit color, gray-scale, and black-and-white images. It supports raw-image data for-



mats and the JPEG standard for image compression and expansion. This version also offers numerous interface and performance improvements, including optimized memory management and faster image handling, as well as TIFF LZW (Lempel-Ziv-Welch) compression and decompression, according to Aldus. Other file formats supported include EPS, GIF, PCX, TIFF, TGA, and BMP. The open architecture of PhotoStyler lets you plug in import and export capabilities as you need them, Aldus says. To run PhotoStyler 1.1, you need a high-resolution graphics card.

$795
Aldus Corp., Seattle, WA; (206) 622-5500
Circle 1059 on Inquiry Card.

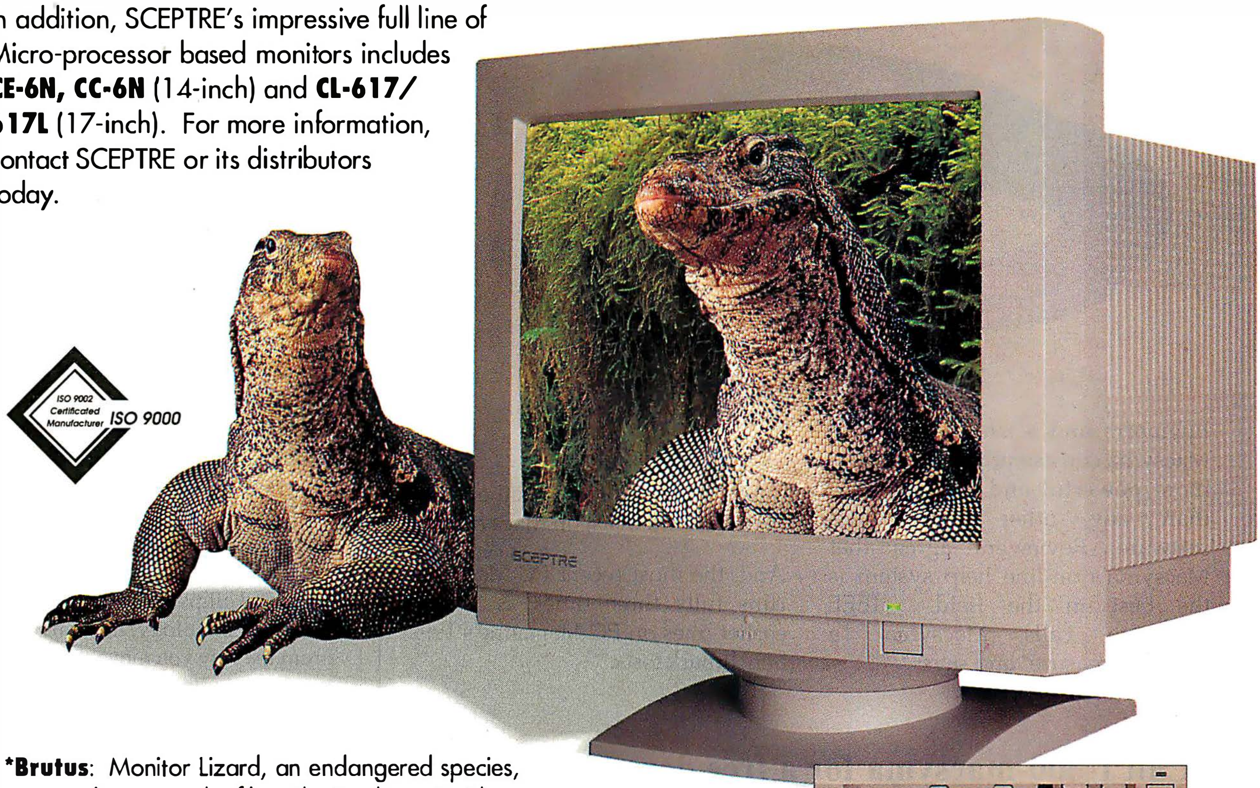
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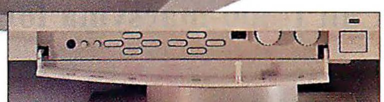
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***Brutus**: Monitor Lizard, an endangered species, recently seen in the film "The Freshman" with Marlon Brando and Matthew Broderick


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Circle 357 on Inquiry Card (RESELLERS: 358).

CA-Cricket Graph for Windows

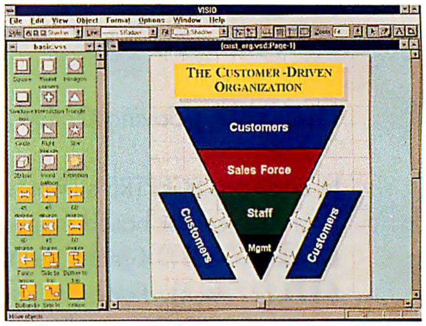
CA-Cricket Graph is a charting application package geared toward scientists, engineers, and business people who need to create graphs and charts for reports, presentations, technical documents, or data analysis. You can import and graph data from files in ASCII, SYLK, DIF, WKS, WK1, WK2, or Windows Clipboard formats. You can manage up to 40 columns by 2700 rows of data directly in the program, rearrange data, or generate new data by using mathematical operators or trigonometric transforms.

Cricket Graph for Windows will let you generate a variety of chart types, including scatter, line, stacked bar, pie, column, area, double Y axes, and polar.

$129
Computer Associates International, Inc., Islandia, NY; (516) 342-5224; fax: (516) 342-5329
Circle 1161 on Inquiry Card.

Visio 2.0

Visio is a drawing program for people who aren't graphics specialists. In fact, the package was developed specifically for computer users who can't draw or don't have the time to learn one of the sophisticated illustration programs. The package takes a drag-and-drop approach to drawing, using ready-made stencils of more than 300 different shapes. These stencils include flow diagrams, business models, engineering schematics, organization charts, facility plans, and network layouts. To draw with them, you click on the shapes, drag them to the drawing area, and then drop them into place. You can then manipulate or create any kind of drawing or diagram, according to Shapeware.



There are tools for drawing all the basic elements you'd need to create a diagram or simple illustration: lines, arcs, rectangles, and ellipses. With its "gesture-recognition" technology, the pencil tool knows from the way you move the mouse whether you want a straight line or a curve.

Other features in Visio include text tools, the ability to automatically connect shapes, conversion from 2-D to 1-D, floating-point precision, global editing, and rotation of objects.

Version 2.0 includes OLE 2.0 object and container support, drag-and-drop capability across applications, and OLE automation. Also added in 2.0 are control handles, an alternative toolbar, multiple stencil views, and pop-up menus.

$299
Shapeware Corp., Seattle, WA; (206) 467-6723; fax: (206) 467-7227
Circle 1162 on Inquiry Card.

PRESENTATION GRAPHICS

CA-Cricket Presents for Windows

With CA-Cricket Presents, you can create a presentation with display-quality graphics, speaker's notes, and audience handouts. The Abstract Outline Processor is a planning tool that helps you turn your ideas into a presentation structure. The templates let you use preselected fonts, colors, and background elements. Auto Presents takes information from an outline and creates a presentation for you. Video Presents is a utility that lets you use your monitor like a slide projector so that you can display your presentation.

Text capabilities include a ruler-based editor that lets you manipulate justification, tabs, kerning and leading, and style. A 100,000-word spelling checker is included. Graph types include scatter, line, area, pie, column, bar, stacked column, and stacked bar charts. You can import TIFF, PCX, Windows metafile, CGM, GIFF, GMF, and EPSF formats.

$199
Computer Associates International, Inc., Islandia, NY; (516) 342-5224
Circle 1163 on Inquiry Card.

Charisma 2.1

Charisma, from Micrografx, is a business graphics program that combines charting, drawing, and presentation capabilities. The package comes with 44 predefined chart types, including technical types, such as linear and exponential. Charisma will let you create additional charts and save them as templates. All the major graphics and data file formats are supported for import and export.

Drawing tools include square, rectangle, circle, a variety of lines, Bézier curve editing, arrowheads, and more, as well as a collection of 2200 clip-art symbols. For presentations, more than 32 templates are included, along with color style sheets. Charisma runs on all Windows-supported networks.

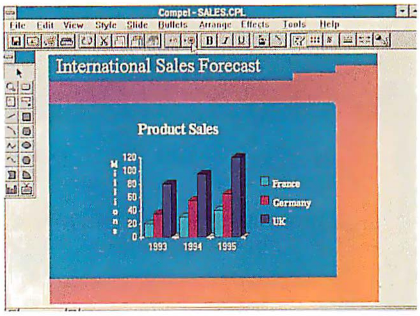
$495
Micrografx, Inc., Richardson, TX; (214) 234-1769; fax: (214) 234-2410
Circle 1164 on Inquiry Card.

Compel 1.0

Compel combines text and graphics capabilities with audio, video, and animation. With Compel, you can create on-screen presentations, slides, overheads, or printouts. You can also create interactive on-screen presentations. And the program's MAPI support lets you send interactive multimedia presentations through Microsoft Mail.

Hyperlinking allows for audience interaction and the ability to navigate through a presentation in customized ways. Users can click on a "hot word" or bullet to instantly provide supporting information in response to questions or comments, or they can skip ahead if they like.

The TwinClick control panel pops up



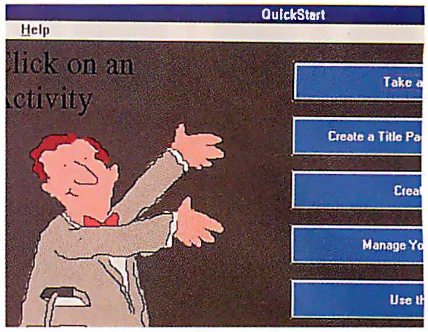
when both mouse buttons are pressed; buttons on the panel let presenters move to any place in the presentation. An Autobuild feature simplifies the creation of a series of slides, according to Asymetrix, and automatically creates links between slides.

Compel supports MCI-compatible multimedia devices under Windows. Built-in sound recorder and animation capabilities are also included. More than 100 MB of multimedia clips come with the Compel package.

$295
Asymetrix Corp., Bellevue, WA; (206) 462-0501; fax: (206) 455-3071
Circle 1165 on Inquiry Card.

Freelance Graphics for Windows Release 2.1

Lotus's Freelance Graphics for Windows helps you build business presentations with QuickStart, an animated on-line tutorial that guides you step by step through the creation process. SmartMaster presentation pages and page layouts let you fill in the blanks to complete a presentation. Release 2.1 comes with 12 new SmartMaster designs, bringing the total to 65.



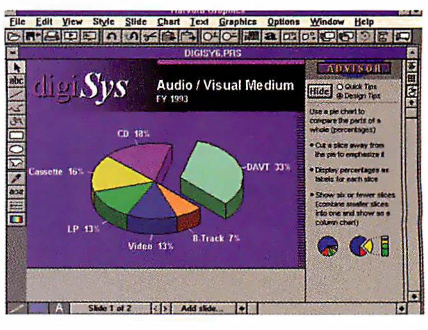
Release 2.1 supports the new WK4 file format created by Lotus 1-2-3 for Windows release 4 in the data import viewer. The program integrates with Lotus Notes in order to create and use the presentation libraries in a Notes environment. Another addition in the latest release is the OLE Screen Show, which lets you specify that presentations embedded as OLE objects automatically play as screen shows when launched. Also included with Freelance Graphics are a PowerPoint 2.0 file import filter, an encapsulated PostScript export filter, and support for the OS/2 metafile for importing and exporting.

$495
Lotus Development Corp., Cambridge, MA; (617) 577-8500
Circle 1166 on Inquiry Card.

Harvard Graphics for Windows 2.0

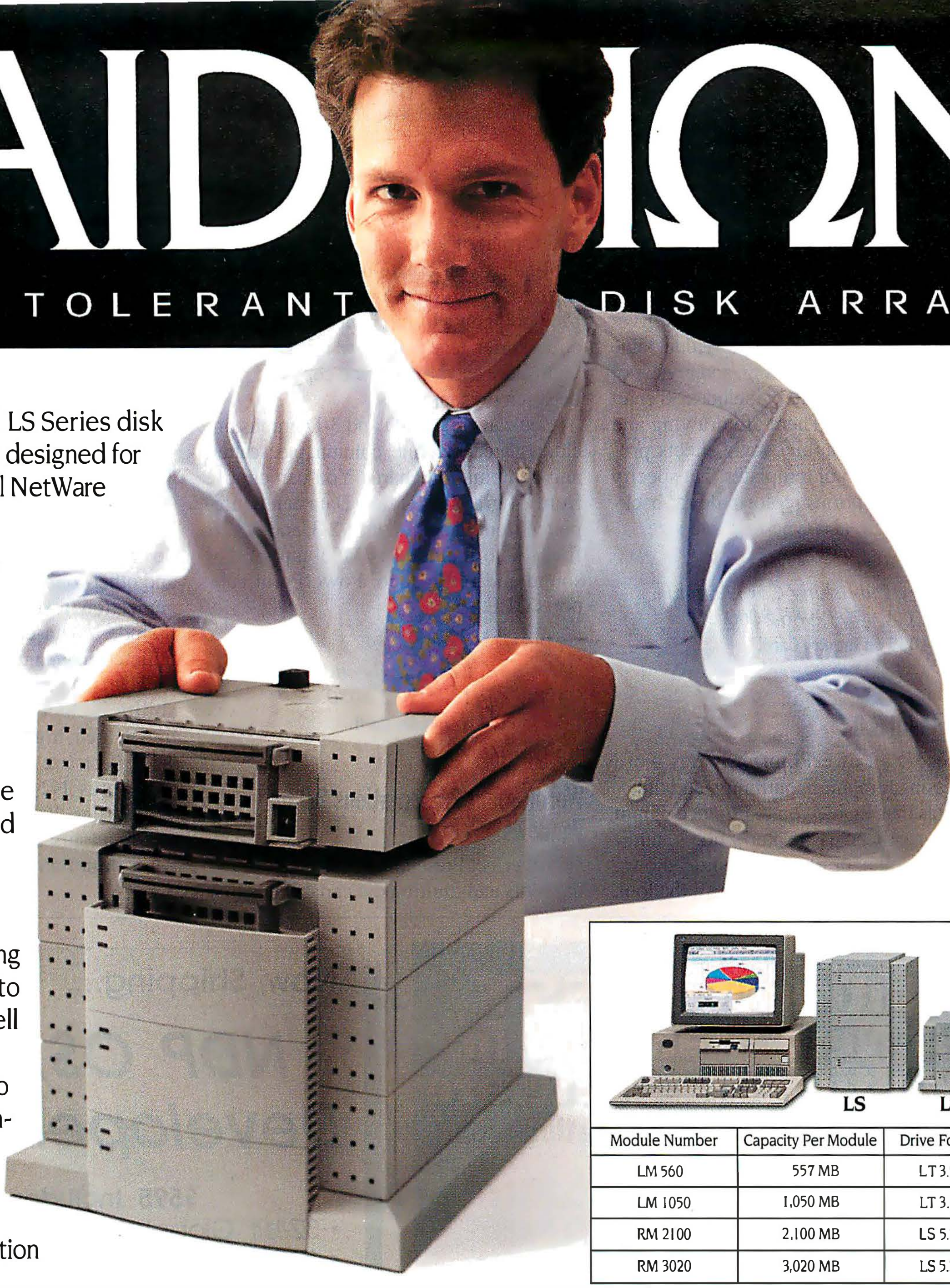
Harvard Graphics for Windows offers three views for creating a presentation: the Slide Sorter, the Outliner, and the Slide Editor. The presentation is stored in one file to simplify presentation editing and organization, according to Software Publishing. Changes in one working view are automatically reflected in the other views of the presentation. You can move between views by clicking on an icon or by selecting the new view from the pull-down menu.

With the Slide Sorter, the presentation is displayed in a collection of slide miniatures, so you can make global modifica-



RAIDION

FAULT-TOLERANT DISK ARRAYS



RAIDION LT and LS Series disk array subsystems are designed for use with either Novell NetWare 3.11/4.0 or IBM OS/2.

MIRROR. RAIDION can be configured with 2 modules to provide mirrored fault tolerance up to 3 GB.

RAID 5. Adding one module to a mirrored array and installing RAIDWARE™ doubles the user capacity by converting the mirrored array to RAID 5. Under Novell NetWare, RAIDION can be expanded to 32 modules per single array with a capacity of 93 GB. Under OS/2, the maximum configuration is 28 modules.

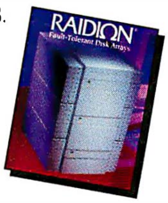
Module Number	Capacity Per Module	Drive Form Factor
LM 560	557 MB	LT 3.5-inch
LM 1050	1,050 MB	LT 3.5-inch
RM 2100	2,100 MB	LS 5.25-inch
RM 3020	3,020 MB	LS 5.25-inch

Other add-on Module capacities available.

RELIABLE. RAIDION can be configured with an on-line spare option that activates automatically upon a drive failure, ensuring continued fault-tolerant operation without human intervention. Hot-Swap and Hot Replacement features allow RAIDION to be serviced while your network remains in operation.

ECONOMICAL. An LT Series three module 2 GB array is just $7,545. An LS Series Raid 5 array with a capacity of 6 GB lists for just $16,980. That's less than $3.00 per MB. It's no wonder Byte Magazine said: "RAIDION's *low price alone makes it worth considering.*" August, 1992.

AWARD WINNING. In a benchmark comparison of disk arrays, Corporate Computing said: *"Raidion was our overall winner with an impressive combination of high performance, low cost, and unparalleled expandability."* May, 1993.



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tions to your presentation. The text-based Outliner lets you organize your ideas and presentations, and it can help you create text or bullet slides. The Slide Editor gives you a graphical view of an individual slide for detailed drawing, editing, and review of data charts. Chart Gallery includes 88 chart and slide layouts. There are drawing and editing tools. Graphics-style sheets provide a collection of templates that specify the charting options, color palette, background design, and type font and size.

$395
Software Publishing Corp., Santa Clara, CA; (408) 986-8000
Circle 1055 on Inquiry Card.

PowerPoint 3.0

Microsoft's PowerPoint provides word processing, graphing, outlining, and drawing tools that enable you to produce 35mm slides, overheads, speaker's notes, audience handouts, or electronic slide shows. The Slide Master lets you control the look and format of your presentation. A shape tool helps you create diagrams. A free-form tool lets you draw figures that combine polygon and freehand drawing. The slide sorter lets you view miniatures of your slides and also lets you copy and paste between presentations.

You can create 2-D and 3-D graphs, including area, bar, line, column, pie, scatter, and combination charts. You can choose from 84 graphing styles. Data can be imported from Excel, Lotus 1-2-3, and ASCII files. Also included is MCI support for sound and AVI video. PowerPoint supports OLE.

$495
Microsoft Corp., Redmond WA; (800) 426-9400, (206) 882-8080
Circle 1167 on Inquiry Card.

WordPerfect Presentations 2.0 for Windows

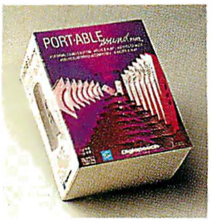
WordPerfect Presentations provides drawing tools and multimedia capabilities that



let you build presentations under Windows. It comes with templates, clip art, and other functions for creating bullet, organization, text, and chart slides. Features include a data-entry tool, an outliner for bulleted lists and text, a spreadsheet tool for charts, and a spelling checker. Charting ability includes line, surface, organizational, area, high-low, pie, and bar charts. 3-D effects are also possible. You can import Lotus 1-2-3, Excel, Quattro Pro, or ASCII files. You can create speaker notes and handouts and use the slide sorter to get a thumbnail view of your presentations.

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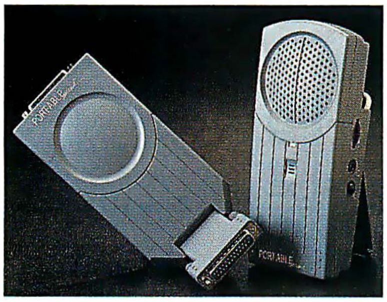


Perk up your presentations. Make training more effective. And, put some guts into your gaming pastimes. Anytime. Anywhere. In fact, if you are not a card carrying member of the computer set, you have to hear PORT·ABLE Sound Plus from DSP Solutions. You know, those real smart people who make simple sound solutions.

PORT·ABLE Sound Plus is the first portable external sound peripheral to deliver 16 Bit CD quality music with stereo audio capabilities. And, since you just plug into your IBM PC or compatible, desktop or laptop parallel port, you do not need an engineering degree or even a screwdriver.

When you compare PORT·ABLE Sound Plus to any other external sound peripherals, you will see why anything else is just noise. PORT·ABLE Sound Plus is based on advanced Digital Signal Processing technology, so you will enjoy the greatest compression capability with the highest quality sounds. Here is something else that will be music to your ears. PORT·ABLE Sound Plus comes complete with everything you need including a high fidelity speaker and built-in microphone. There is an "Audio-in" for a CD or tape player and a "Line-out" for external powered stereo speakers. Even a built-in smart parallel port pass through so you can keep printing.

Whether you take your work across the hall or across the country, with PORT·ABLE Sound Plus, you have all the cards you need to play right in your hip pocket. The hinged design lets you flip up the unit if you are short on desk space or lap space. And, the power will always be with you whether you use rechargeable or non-rechargeable AA batteries. PORT·ABLE Sound Plus also comes equipped with an AC/DC power converter.



As a bonus, you will get all the software you need to communicate. Like Lotus Sound™ an OLE server for Windows 3.1. WinReader for Windows 3.1, a handy text-to-speech utility. DSP Solution's DOSTalk and DOSReader text-to-speech applications. Show & Tell For Kids™ for Windows – an easy to use MultiMedia Authoring program. It is also Sound Blaster and AdLib compatible.

Why compromise on quality, portability, compatibility or affordability? When all the cards are on the table, PORT·ABLE Sound Plus from DSP Solutions is your ace in the hole. Suggested retail is only $198.95.



To order or obtain more information about PORT·ABLE Sound Plus, write or call DSP Solutions, or, contact your local dealer.

Sales Office: 550 Main Street, Suite J, Placerville, California 95667. Telephone: (916) 621-1787. Fax (916) 621-2093.

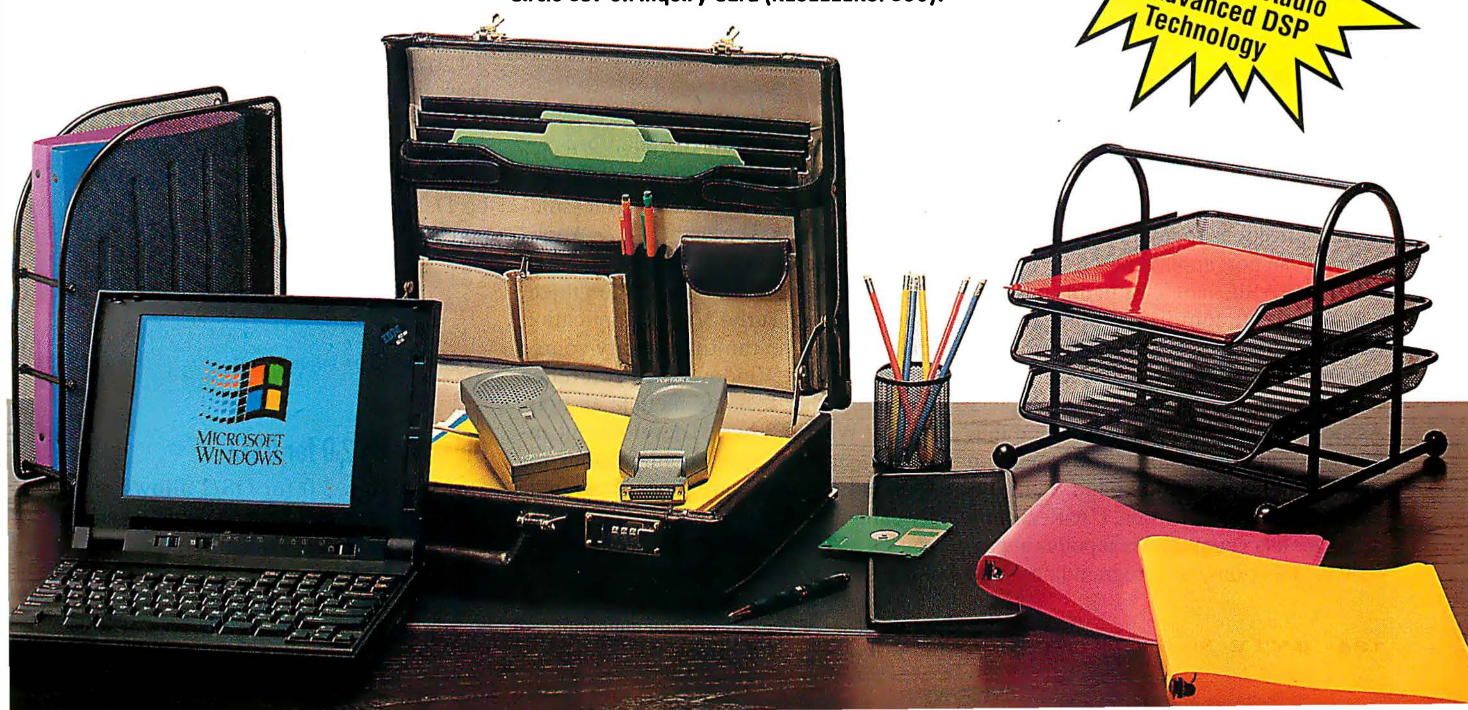
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DSP™ SOLUTIONS

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• Sound Blaster Compatible
• 16 Bit CD Audio
• Advanced DSP Technology

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The multimedia support lets you attach WAV files. WordPerfect Presentations comes with 100 MIDI files.

$495
WordPerfect Corp., Orem, UT; (801) 225-5000, (800) 321-4566
Circle 1168 on Inquiry Card.

DEVELOPMENT TOOLS

CA-dbFast 2.0

CA-dbFast is a stand-alone dBase-compatible application development system for Windows. The Visual Designer allows you to take advantage of object-oriented design and other Windows features. You can run dBase III Plus applications concurrently with your new CA-dBFast applications, according to Computer Associates.

CA-dBFast includes extensions to dBase that allow applications to use Windows resources, fonts, pull-down menus, bit maps, sizable Windows, and more. CA-dBFast also has multiuser capabilities, so you can share data on your network.

An interactive debugger supports source-level single-stepping and breakpoints. Extensible code templates let you standardize your programming efforts. And an object relationship manager maintains the relationships between project components.

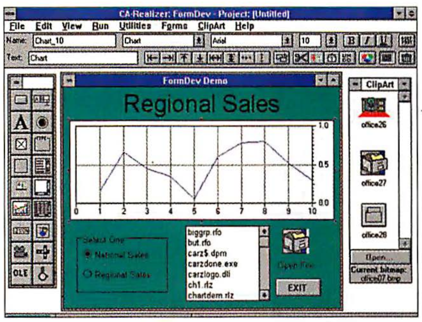
$550
Computer Associates, Inc., Islandia, NY; (516) 342-5224; fax: (516) 342-5329
Circle 1169 on Inquiry Card.

CA-Realizer 2.0 for Windows and OS/2

CA-Realizer 2.0 lets you create multiplatform applications for Windows and OS/2, and you can port applications to Windows NT. The BASIC language in this package lets you create families within families with dynamic record-like collections of variables that can be expanded at run time with new elements at any level, Computer Associates says. You can create and manipulate multidimensional arrays with up to 30 dimensions and expand them dynamically in any dimension. CA-Realizer's debugger lets you place breakpoints at procedures, functions, and program lines. You can also display the contents of an array in the variable list box.

The new release of CA-Realizer for Windows and OS/2 lets you launch FormDev directly from the CA-Realizer Run menu. You can also create complete projects and edit multiple forms at the same time and cut and paste one or more objects between forms. You can align objects to adjustable grids with auto snapping and alignment, and you can resize and move objects as they appear. You can also generate CA-Realizer BASIC code from FormDev, edit it, and then reimport the file with its changes intact. And you can generate database query and entry forms automatically from any Xbase file, Computer Associates reports.

The package provides a range of chart types. The program's forms capability in-

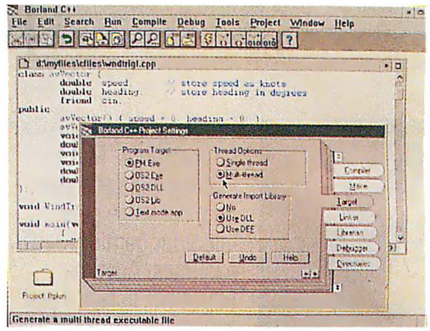


cludes support for PCX and metafiles along with Windows bit maps. OLE objects are also supported. You can import and export Xbase database files.

$247
Computer Associates International, Inc., Islandia, NY; (516) 342-5224; fax: (516) 342-5329
Circle 1170 on Inquiry Card.

Borland C++ for Windows and OS/2

Borland C++ 3.1 is designed as a complete development system for professional programmers. Borland C++ & Application Frameworks 3.1 incorporates all of Borland C++ 3.1, including the Object Windows and Turbo Vision application frameworks, the run-time library source code, and the Windows API reference manual. Other features include an optimizing Windows-hosted development environment, new global optimizations for C++ and 386 code generations, a new utility called winSpector for determining the causes of UAEs, and integrated resource compilation.



Like Borland C++ 3.1, Borland C++ for OS/2 has a GUI-based integrated development environment, global optimization, support for C++ 3.0, object-oriented debugging, precompiled headers, the ability to transfer to user-defined programs and tools, and smart project management. In addition, it lets you create OS/2 executable files, libraries, and DLLs, as well as text-mode programs and Presentation Manager applications.

Borland C++ 3.1, $495; Borland C++ & Application Frameworks 3.1, $749; Borland C++ for OS/2, $495
Borland International, Inc., Scotts Valley, CA; (408) 438-8400
Circle 1171 on Inquiry Card.

Turbo Tools for Windows

Turbo C++ for Windows 3.1 is designed for entry-level C and C++ users. It includes the tools you need for creating Windows applications but doesn't include the professional tool set, the optimizing compiler, or the library source code.

Turbo Pascal for Windows 1.5 lets users take advantage of the features in Windows 3.1, such as OLE, common dialog boxes, drag-and-drop, and TrueType fonts. New features in Turbo Pascal for Windows 1.5 include a Resource Workshop, which is a graphical design tool; Speedbar; and Turbo Debugger for Windows 3.1 with Super VGA support.

$149.95
Borland International, Inc., Scotts Valley, CA; (408) 438-8400
Circle 1172 on Inquiry Card.

ObjectVision 2.0 for OS/2

ObjectVision 2.0 for OS/2 allows programmers and nonprogrammers to create business applications for Windows and OS/2 2.0. ObjectVision includes provisions

for three aspects of application creation: application interface, business rules or application logic, and connection to databases and other applications. Features designed to take advantage of OS/2 2.0 include full 32-bit implementation, multithreading, integrated support of the OS/2 Database Manager through IBM's optional extended services capability, and an interface to the REXX programming language.

$249.95
Borland International, Inc., Scotts Valley, CA; (408) 438-8400
Circle 1173 on Inquiry Card.

Borland Pascal with Objects 7.0

This package is designed for professional DOS and Windows programmers, and it enables them to create applications for three platforms: DOS, DOS Protected Mode Interface, and Windows. Borland Pascal with Objects 7.0 features technology that lets programmers share code libraries between DOS and Windows. The development language also features DPMI Application Creation, DOS DLLs, DOS and Windows Object Browsers, and six new compiler optimizations, including 386 32-bit math operations.

$495
Borland International, Inc., Scotts Valley, CA; (408) 438-8400
Circle 1174 on Inquiry Card.

FORTRAN PowerStation 1.0

Microsoft's FORTRAN PowerStation 1.0 is an implementation of FORTRAN that lets developers create 32-bit protected-mode DOS applications. The product comes with Visual Workbench, a Windows integrated development environment that lets developers move seamlessly between the compiler, editor, and debugger.

In addition to creating 32-bit protected-mode executable files and libraries, FORTRAN PowerStation provides support for 32-bit graphics in VGA, Super VGA, and VESA formats. The compiler is a 32-bit executable file, so it handles programs up to 4 GB. FORTRAN PowerStation comes with a set of global optimizations, including optimizations for expressions, sorts, peepholes, and dead-loop removal.

FORTRAN PowerStation is compatible with ANSI FORTRAN 77 and includes VAX and IBM extensions. The package also comes with a 387 emulator. Microsoft recently announced a version of the FORTRAN compiler for NT that will let developers create 32-bit applications for NT and DOS.

$495
Microsoft Corp., Redmond, WA; (206) 882-8080; fax: (206) 936-7329
Circle 1175 on Inquiry Card.

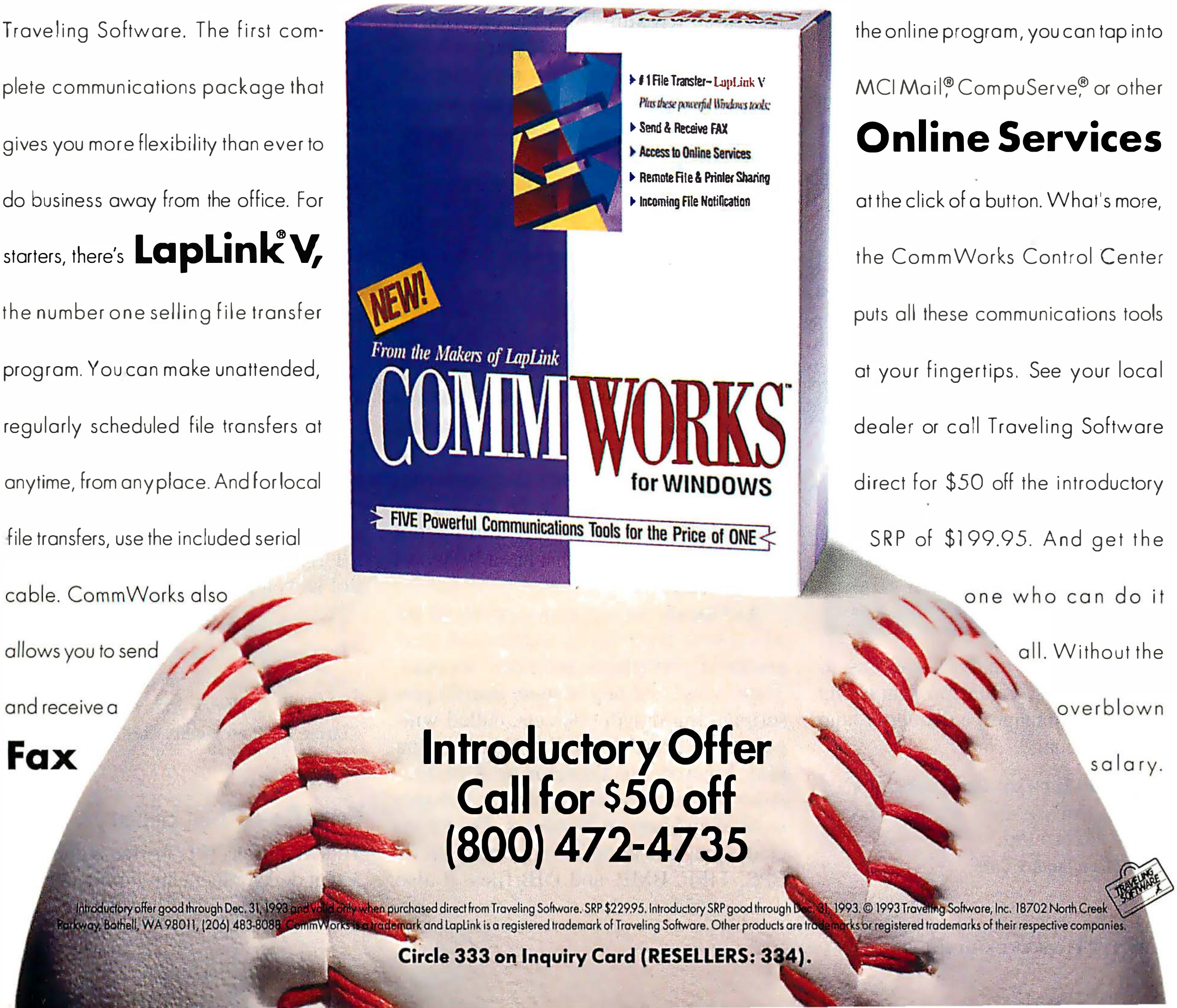
HOOPS

With HOOPS you can build interactive graphics applications that combine imagery with instantaneous response.

HOOPS provides a single interface to all major platforms. It's a 3-D graphics

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(800) 472-4735

Introductory offer good through Dec. 31, 1993 and valid only when purchased direct from Traveling Software. SRP $229.95. Introductory SRP good through Dec. 31, 1993. © 1993 Traveling Software, Inc. 18702 North Creek Parkway, Bothell, WA 98011, (206) 483-8088. CommWorks is a trademark and LapLink is a registered trademark of Traveling Software. Other products are trademarks or registered trademarks of their respective companies.

Circle 333 on Inquiry Card (RESELLERS: 334).

API that is source code–compatible with workstations and PCs. The scalable device interface adjusts for your hardware's specific functionality.

HOOPS incorporates a graphics database that has built-in links to connect graphical and nongraphical data. It also has an intelligent rendering engine that can generate pictures on a variety of display and hard-copy devices. An integrated input event manager captures and processes input events generated by a mouse, keyboard, or other device. Graphics tools and techniques let you perform Gouraud and Phong shading of complex solid objects and apply material properties including transparency and reflectivity.

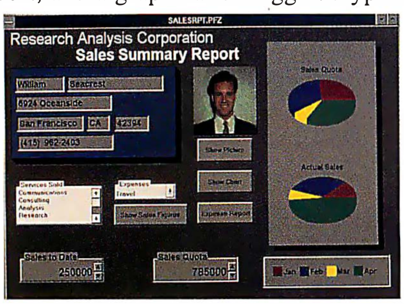
HOOPS is compatible with X Window System and PEX. Data can be stored or exchanged with other applications by using the HOOPS Metafile Format.

$5000 for a single-developer license
Ithaca Software, Alameda, CA; (510) 523-5900; fax: (510) 523-2880
Circle 1176 on Inquiry Card.

Informix-HyperScript Tools

Informix-HyperScript Tools is a multiplatform visual programming environment that lets you create graphical applications for Windows, Unix, and Macintosh. HyperScript Tools also includes an extended version of Informix's HyperScript language, along with additional modules.

HyperScript Tools provides high-level programming aides, including screen and menu painters, a spreadsheet, SQL support, and a graphical debugger. HyperScript Tools also has analysis and presentation capabilities, visual programming tools, a project manager, a debugger, and a scripting language.



$2495; $400 for run-time versions
Informix Software, Inc., Menlo Park CA; (415) 926-6300
Circle 1177 on Inquiry Card.

Mirrors

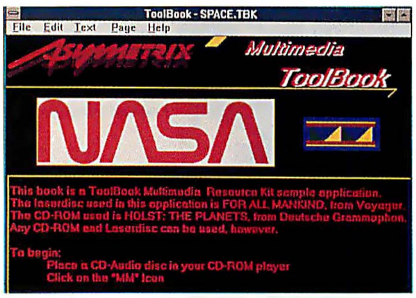
Micrografx Mirrors, a toolkit for porting Windows applications to OS/2, is a 32-bit DLL that emulates Windows under OS/2. When an application running under OS/2 calls a Windows function, Mirrors intercepts the call and implements it using functions within the OS/2 system DLL. Mirrors transforms the data that is returned by OS/2 and passes it back in a form Windows applications understand.

Some of the key functions of Mirrors are support for 16-bit applications; automated conversion of bit maps, icons, and help files; debug and nondebug versions of the Mirrors DLL; DOS3CALL interrupt support; and DOS and OS/2 host-independent file I/O libraries.

$495
Micrografx, Inc., Richardson, TX; (214) 234-6018; fax: (214) 234-2410
Circle 1178 on Inquiry Card.

Toolbook Multimedia Resource Kit

Asymetrix says its Toolbook Multimedia Resource Kit simplifies the creation of multimedia applications. If you are building an application with motion video, you can paste the prebuilt VCR-like control panel into your application to provide play, pause, stop, fast forward, and rewind functions—without doing any programming. The Resource Kit supports DLLs and lets you link to and control any multimedia hardware and software that has a Windows DLL library.



An OpenScript function supports all the Microsoft high-level application programming interfaces and timer services. There's also a library of more than 85 prescripted multimedia objects, called widgets. And there's a facility that lets you play MacroMind Director or Autodesk Animator animation and palettized images in child and pop-up Windows. The kit includes graphics filters for importing DRW, EPS, TIFF, BMP, and DIB files. It also supports 256-color bit maps.

To run the Resource Kit you need ToolBook for Windows, Microsoft Multimedia Windows, and 2 MB of RAM.

$300
Asymetrix, Bellevue WA; (206) 637-1500; fax: (206) 454-0672
Circle 1179 on Inquiry Card.

Visual Basic 3.0

The Microsoft Access 1.1 database engine is integrated into Visual Basic 3.0, providing venues to Access, FoxPro, dBase, Paradox, and other client/server databases available through ODBC (Open Database Connectivity). The engine also has a query capability that parses SQL, the ability to perform distributed joins, updatable queries, query optimization, and international collating orders.

The Programmatic Layer of Visual Basic 3.0 is a suite of objects that drives the database engine and lets you define a query, field, index, or table and gives you access to data stored in a table, as well as the ability to execute a query, manipulate the results, and update the database. The Visual Layer of Visual Basic 3.0 offers data-aware controls that you can link to a query.

For designing reports, Visual Basic 3.0 Professional Edition includes Crystal Reports 2.0, which uses a custom control to simplify embedding reports in applications.

Visual Basic 3.0 has tools that help you create and manipulate data as well as distribute applications. New controls help you create hierarchical list boxes, to issue queries and navigate through the results, and more.

Unlike the Professional Edition, the Standard Edition lacks full ODBC support, a few drivers, the programmatic access layer, Crystal Reports, some data-aware controls, and the on-line Windows 3.1 API reference and the Custom Control Development Kit.

$199, Standard Edition; $395, Professional Edition
Microsoft Corp., Redmond, WA; (206) 882-8080; fax: (206) 936-7329
Circle 1180 on Inquiry Card.

Visual C++ 32-bit Edition

This Windows NT–hosted and integrated 32-bit development environment for C and

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	ViewSonic 15	ViewSonic 17	ViewSonic 20	ViewSonic 21
Screen Size	15"	17"	20"	21"
Dot Pitch (mm)	0.28	0.27	0.28	0.25
Horizontal Frequency (KHz)	30-64	30-82	30-82	30-82
1600 x 1280 Non-Interlaced		■	■	■
Maximum Refresh Rate (Hz) at 1280 x 1024 NI	60	76	76	76
Flat Square Screen	■	■		■
ViewMatch™ Color Control	■*	■	■	■
Low Radiation (MPRII)	■	■	■	■
Suggested List	$549	$1,299	$2,099	$2,399

ViewSonic®

20480 Business Pkwy Walnut, CA 91789
Tel. (909) 869-7976 Fax (909) 869-7958

ViewSonic 21 screen image by SPATIEL TECHNOLOGY INC., Boulder, CO. Created with **ACIS**® Geometric Modeler and rendered with Visualization Husk.

*Color temperature select 9300°K or 6550°K only.

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Circle 335 on Inquiry Card (RESELLERS: 336).



C++ developers will be the first PC-based development system with all software and documentation distributed on CD-ROM, according to Microsoft. The on-line documentation contains more than 8000 pages of information, including references to the Win32 SDK, C, and C++.

Visual C++ 32-bit Edition comes with Foundation Class Library 2.0. According to Microsoft, this library offers the building blocks that encapsulate thousands of lines of reusable, robust, and optimized C++ code for Windows-based applications.

AppWizard lets you create a skeleton application that supports these building blocks, and ClassWizard lets you connect user-interface elements and application code.

AppStudio lets you create, edit, and browse application resources. And Visual Workbench gives you an integrated editor, debugger, browser, and profiler. Also included is Spy++, an analysis tool that gives you information on threads, processes, and windows in Win32-based applications.

To run Visual C++ 32-bit Edition you need at least 16 MB of RAM, 80 MB of hard disk space for a full installation, a VGA or higher display, and a CD-ROM drive supported by NT.

$599
Microsoft Corp., Redmond WA; (206) 882-8080; fax: (206) 936-7329
Circle 1181 on Inquiry Card.

Watcom C/C++ 32

This is a professional, multiplatform, 32-bit optimizing C and C++ development system for extended DOS, Novell NLM, OS/2 2.0, Windows NT, and Win32s. The development package implements instruction scheduling to deliver better performance on 486 and Pentium processors, according to Watcom.

The compiler can create a single, high-performance executable file that runs on 386, 486, and Pentium processors. It supports a range of 32-bit Intel 80x86 host and target platforms. The package comes with a debugger, C and C++ compilers, a profiler, a royalty-free DOS extender with 32 MB of VMM support, licensed components of the Microsoft Windows 3.1 SDK, OS/2 2.1 Toolkit, and NetWare 4.0 SDK, and more.

To run C/C++ 32 you need DOS 3.3 or higher, OS/2 2.0, or Windows NT and 3 MB of available RAM.

$599
Watcom, Waterloo, Ontario, Canada; (519) 886-3700; fax: (519) 747-4971
Circle 1182 on Inquiry Card.

Watcom FORTRAN 77 32

FORTRAN 77 32 is a multiplatform 32-bit optimizing FORTRAN development system for extended DOS, Novell NLM, OS/2 2.0, Windows NT, 32-bit Windows 3.0, and AutoCAD ADS. To port code from other platforms, FORTRAN 77 32 has VAX, FORTRAN 90, Microsoft, and IBM VS language extensions.

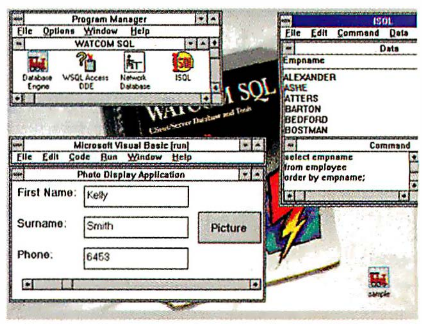
The product supports the full FORTRAN 77 ANSI standard, and it is compatible with IBM's SAA FORTRAN language definition. It includes a compiler, a linker, a debugger, a profiler, a royalty-free DOS extender with 32 MB of VMM support, and licensed components of the Microsoft 3.1 SDK, OS/2 2.1 Toolkit, and NetWare 4.0 SDK.

To run FORTRAN 77 32 you need DOS 3.3 or higher, OS/2 2.0 or higher, or Windows NT and at least 3 MB of available RAM.

$599
Watcom, Waterloo, Ontario, Canada; (519) 886-3700; fax: (519) 747-4971
Circle 1183 on Inquiry Card.

Watcom SQL for Windows

Watcom SQL for Windows is a client/server DBMS that includes a stand-alone single-user SQL database server. It lets you



develop and deploy single-user applications and develop applications for use with the Watcom SQL Network Server Edition.

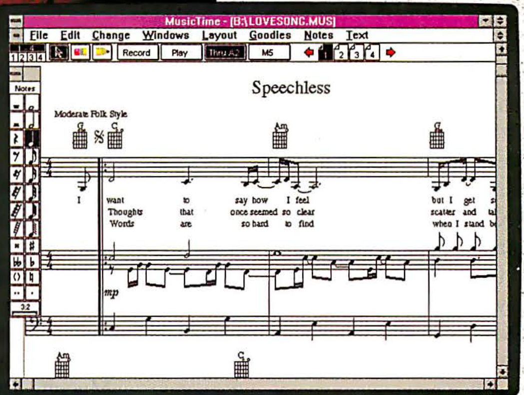
Watcom SQL supports the Microsoft Open Database Connectivity; this enables you to use a range of front-end tools and



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MusicTime couldn't be easier to use.

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For your copy of MusicTime, call Passport or visit your nearest computer or music store. If you're tired of just playing games with your sound card, get MusicTime and turn your beeps and blasts into be-bop and hip-hop.





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applications. The database also includes ANSI and IBM SAA standard embedded SQL support for C/C++ application development with Watcom, Microsoft, and Borland compilers.

The package comes with both 16- and 32-bit versions of the database server, interactive SQL, embedded SQL/C preprocessor, and SQL libraries.

$395
Watcom, Waterloo, Ontario, Canada; (519) 886-3700; fax: (519) 747-4971
Circle 1184 on Inquiry Card.

Watcom VX.REXX

Watcom calls VX.REXX a visual solution builder for OS/2. It's a development environment for creating applications that make use of OS/2 2.0 and the Presentation Manager interface. It combines a project management facility, a visual designer, and an interactive source-level debugger.

With the visual designer you can create Presentation Manager interface objects, customize their properties, and attach REXX procedures to the objects. You can build and debug your application without leaving the development environment. Then you can package your application as an EXE file or PM macro for royalty-free distribution.

$299
Watcom, Waterloo, Ontario, Canada; (519) 886-3700; fax: (519) 747-4971
Circle 1185 on Inquiry Card.

DESKTOP PUBLISHING

FrameMaker 4

FrameMaker is aimed primarily at professionals who need to produce long, complex documents—books, manuals, business plans, and financial reports with numbered sections, sophisticated page layouts, tables, cross-references, footnotes, indexes, and lengthy tables of contents. As you might guess from the name, the program takes a frame-centric approach to laying out pages. The latest version for Windows includes more than 100 new features that make it more accessible and easier to use for creating demanding documents, according to Frame Technology. Leading the list of enhancements is a new user interface and features such as the ability to compare documents, better graphics handling, a thesaurus, functions for preparing color separations, and complete rotation of text and graphics. System administrators can customize the menus.

As in earlier editions, Version 4 lets you create conditional text and create formats for complex mathematical equations. Also included is a utility that lets you distribute documents across a network or on CD-ROM.

FrameMaker 4 is also available for Sun and Hewlett-Packard Unix workstations and for the Macintosh. FrameMaker 4 shares files transparently across these platforms with no file conversion.

$795
Frame Technology Corp., San Jose, CA; (408) 433-3311; fax: (408) 433-1928
Circle 1186 on Inquiry Card.

PageMaker 5.0

The latest version of PageMaker features advances in precision and control of text, integration with other software, and a wider range of printed communications that it can produce. With version 5.0, functions are identical under the Windows and Macintosh operating systems.

PageMaker 5.0 is able to rotate and skew text and graphics in 0.01-degree increments, along with horizontal and vertical reflection of objects. You can also edit the rotated text and crop rotated graphics directly in page layout view. Version 5.0 produces process-color separations of complete pages including text and graphics, as well as imported CMYK TIFF, DCS, and EPS images. Pantone color is also supported.

PageMaker now comes with Aldus Additions technology, which lets you tailor your desktop publishing operations to specific needs. More than 20 Aldus Additions come with 5.0, including Expert Kerning.

$895
Aldus Corp., Seattle, WA; (206) 622-5500
Circle 1187 on Inquiry Card.

PagePlus 2.0 for Windows

PagePlus 2.0 offers full-color publishing capabilities, text frames, styles and templates, and more. It allows automatic flowing of text, kerning, importing of pictures, and irregular text wrapping. It also offers drawing tools, rulers and guides, multiple levels of zooming, a table editor, and provision for color separations.

Three Publishing Packs are available as add-ons, including TypePlus 2.0 for text effects, ArtPack, a collection of over 500 color images, and FontPack, with over 100 TrueType typefaces.

$59.95
Serif, Inc., Nashua, NH; (603) 889-8650; fax: (603) 889-1127
Circle 1188 on Inquiry Card.

Microsoft Publisher 2.0

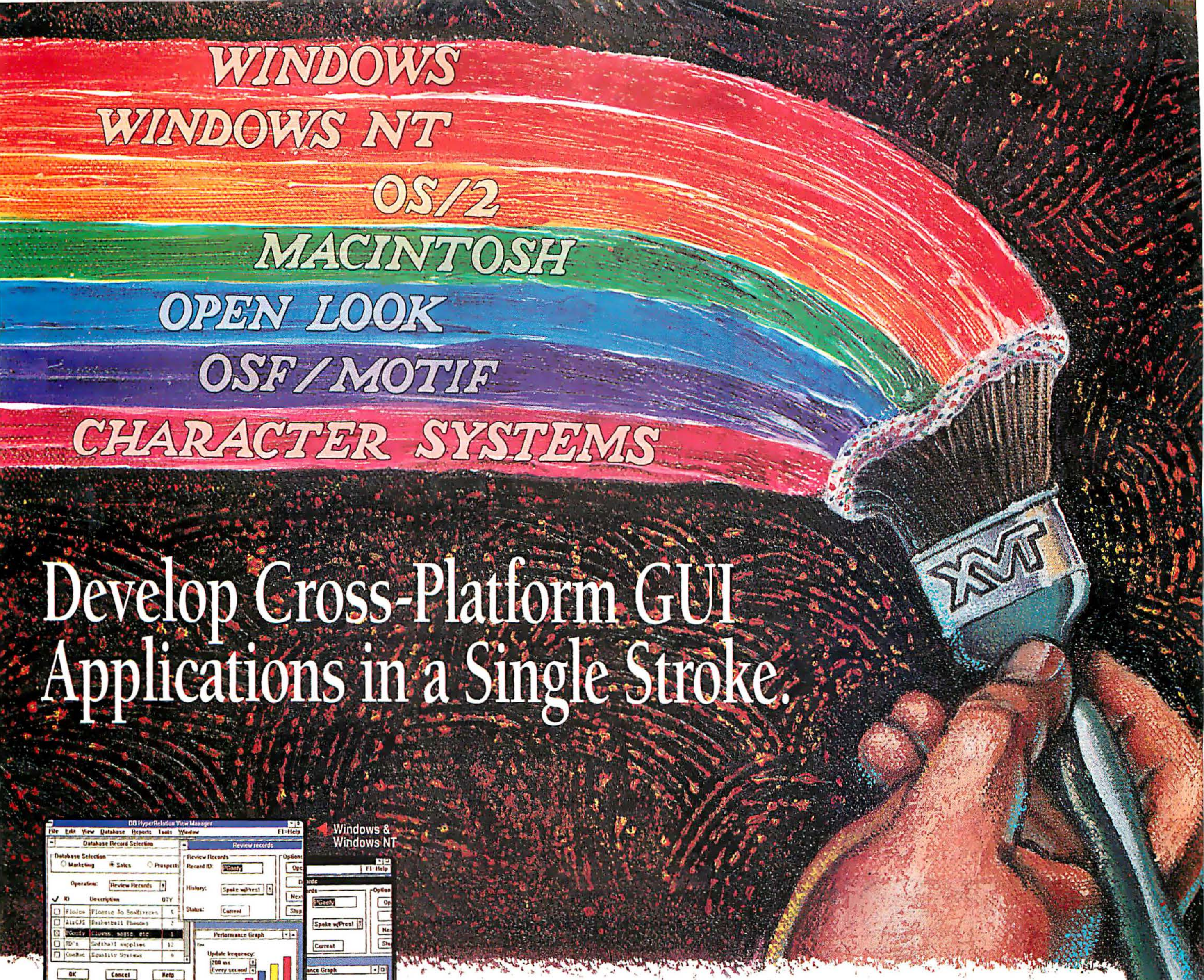
Version 2.0 of Microsoft Publisher includes Cue Cards, enhanced PageWizards, Quick Demos, a Layout Checker, and Print Troubleshooter. There are also 35 document templates and a text-effects feature called Word Art that can be used with TrueType fonts. Among the improved type features are kerning, tracking, auto-hyphenation, and justification capabilities. Microsoft Publisher 2.0 supports OLE, TWAIN scanners, and Kodak Photo CD.

$199
Microsoft Corp., Redmond WA; (206) 882-8080; fax: (206) 936-7329
Circle 1189 on Inquiry Card.

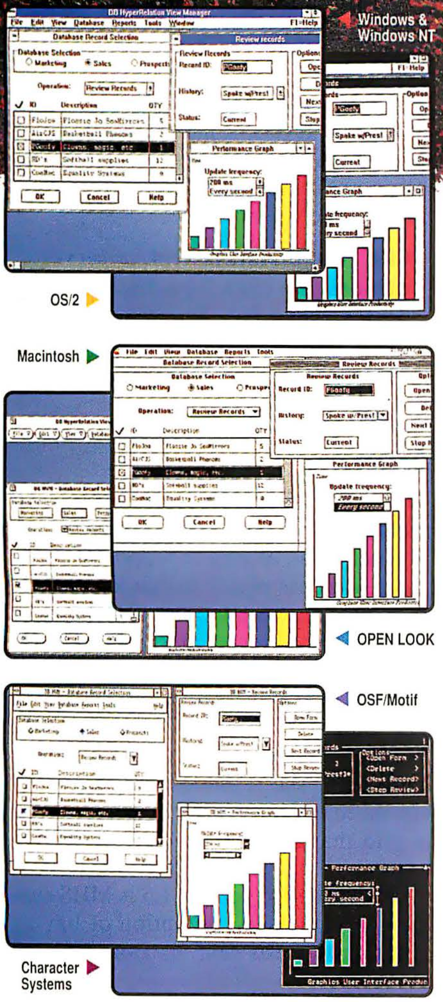
QuarkXPress 3.2 for Windows

The newest version of QuarkXPress for Windows comes with color-related features, such as the EfiColor XTension from Electronics for Imaging. The EfiColor XTension lets you separate imported continuous-tone color images from within QuarkXPress and ensures consistent color matching across an array of display and output devices, including offset presses, EFI says. The XTension includes information about the capabilities and limitations of each device and will alert you if a color cannot be displayed or printed by a device.

Quark claims that version 3.2 runs substantially faster than 3.1. There are more than 20 new features, including Collect for Output, which allows you to save a document and related graphics in one file for shipping to a service bureau. (The files that are needed to print the document are



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Circle 338 on Inquiry Card (RESELLERS: 339).

automatically saved with them.) The program also offers an auto backup function, the ability to save a page in EPS format, a word processor, and a drag-and-drop editing feature.

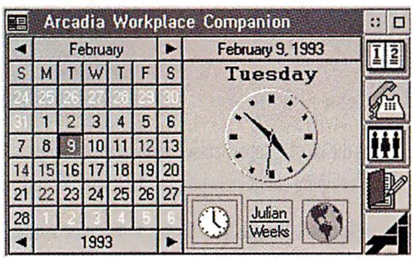
With version 3.2 you can save in the following graphics formats: PC and Mac Color, PC and Mac B&W, PC and Mac DCS, and PC and Mac DCS 2.0.

$895
Quark, Inc., Denver, CO; (303) 894-8888; fax: (303) 894-3394
Circle 1190 on Inquiry Card.

PERSONAL INFORMATION MANAGERS

Arcadia Workplace Companion for OS/2

The Arcadia Workplace Companion is designed for the OS/2 2.1 32-bit Workplace Shell environment and uses pop-up menus, notebook controls, and drag-and-drop techniques. The program includes a calendar

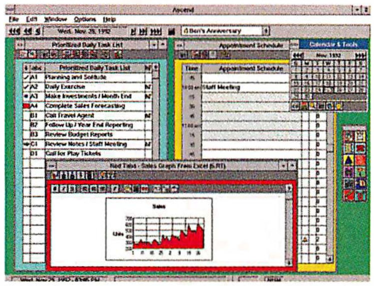


and clock module from which you can launch a visual appointment book for scheduling, a telephone and address book, a priority-based to-do list, and a notepad. The clock/calendar provides customizable alarms. The launching pad of the clock/calendar module is used to activate other modules of the program.

$149.95
Arcadia Technologies, Inc., Arcadia, CA; (818) 446-6945; fax: (818) 447-4212
Circle 1191 on Inquiry Card.

Ascend 4.0

Franklin Quest, producer of this product, is a time-management training company that put its concepts on disk so you can manage your time directly on computer or print out day-planner pages. Ascend is both a



personal information manager and a contact manager for Windows. It lets you print tasks, appointments, calendars, values and goals, phone and address lists, and contact information. The package can dial phone numbers for you.

Ascend is compatible with Novell, LAN Manager, and other networks. You can share calendars and other data with other Ascend users on a network. You can also use a groupware feature to find available time slots for group appointments and schedule them with or without confirmation. Ascend features password protection for security.

Version 4.0 supports OLE and DDE. It also has a monthly view and weekly view, a summary report, and an enhanced values and goals module. In addition, Ascend 4.0 supports pen computing with features such as gesture recognition, freehand drawing, and push buttons.

$199
Franklin Quest Co., Salt Lake City, UT; (801) 975-9992; fax: (801) 975-9995
Circle 1192 on Inquiry Card.

CalendarMaker for Windows

CalendarMaker, as its name implies, is an application that creates calendars. You can print them and use them as stand-alone calendars, or you can use them in other documents. You can create three types of calendars and choose type styles, views, and more. The program can produce calendars for past or future years.

$69.95
CE Software, Inc., West Des Moines, IA; (515) 224-1995; fax: (515) 224-4534
Circle 1193 on Inquiry Card.

Commence 2.0

Commence 2.0 includes calendar, contact management, and task management features in addition to the ability to share databases, views, categories, and connections over networks. Commence 2.0 has a database synchronization feature for PCs not connected to a network.

Commence uses agent technology that gives you a way of defining triggers and actions to automate routine tasks. A trigger defines the event that will cause the agent to operate, and the actions determine what task Commence will perform. There are time, data, and manually activated triggers.

The new version employs a distributed database architecture, letting you disconnect from the network and retain a local copy of the database to use at home or on the road. When you connect to the network, changes made while you were disconnected are automatically updated and synchronized. Sync Link, the technology that performs the synchronization, provides a compressed file export utility that handles incremental changes.

Commence 2.0 comes with two predefined databases. Each allows you to save data in up to 300 categories, each capable of storing up to 16,000 items. The categories consist of named fields that you can add, edit, or delete. Security features include four levels of password protection for the LAN-based version, and scrambling and password protection for the stand-alone version.

$395, stand-alone, client, or server editions; network 3-packs, $695
Jensen-Jones, Inc., Red Bank, NJ; (908) 530-4666; fax: (908) 530-9827
Circle 1194 on Inquiry Card.

OnTime 1.5

The new version of OnTime for Windows includes import and export support for several palmtops, as well as support for WinBeep wireless communication software that transmits messages to alphanumeric pagers. A feature called RSVP lets users who originate meeting requests require recipients to respond with a "yes," "no," or "pending." A reminder icon stays at the bottom of the recipient's calendar screens until he or she responds. Originators of the meeting can get a list of attendees and a grid that indicates each person's response.

Also added to version 1.5 is MHS support, giving users the option of having meeting requests sent via E-mail (using

Beyond Mail, DaVinci eMail, cc:Mail, or Microsoft Mail).

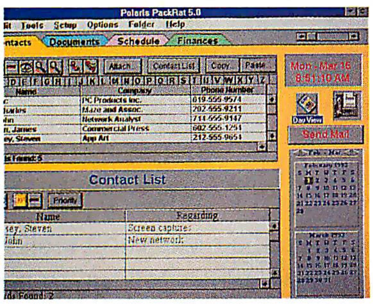
OnTime for Networks now installs from either the DOS or the Windows environment. A new report generator documents items such as user lists, different users' access rights, and notification messages. In addition, you can purchase activation keys that use codes to unlock additional users. For security, you can password-protect the setup or move it to a private directory.

To work with your palmtop, OnTime automatically configures and maintains the desktop-to-palmtop communication settings, according to Campbell Services. OnTime works with the Hewlett-Packard 95LX series, the Sharp Wizard, the Psion Series 3, the Casio Boss series, and Casio models R10 and R20. OnTime will soon offer support for the HP 100LX.

$129.95, single-user version; $356, network version for three users
Campbell Services, Inc., Southfield, MI; (313) 559-5955
Circle 1195 on Inquiry Card.

PackRat 5.0

The new version of PackRat 5.0 includes customizable workspaces; customizable form fields, which you can change to reflect the kind of information you need; and SmartStart, which gives you a starter set of folder workspaces geared toward professions such as MIS management, law, and sales. The E-mail compatibility supports



systems that conform to MAPI and VIM standards. A new macro language lets you automate operations and create links with other applications. Hot Links let you get status reports from other applications via DDE while working in PackRat.

$395
Polaris Software, San Diego, CA; (619) 592-7400; fax: (619) 592-7430
Circle 1196 on Inquiry Card.

ACCOUNTING

ACCPAC Simply Accounting for Windows and OS/2

ACCPAC Simply Accounting for Windows and OS/2 is an entry-level accounting program that is part of the ACCPAC family of accounting software from Computer Associates. The package provides general ledger, accounts receivable/payable, payroll, inventory, and project costing modules. The package can handle up to 5000 ledger accounts and 32,000 customers, vendors, employees, inventory items, jobs, and projects.

Version 2.0 includes the ability to enter cash purchases or cash sales as singular transactions rather than through multiple journals. It also includes flexible transaction handling and enhanced forms handling, with multiple form sizes for invoices, checks, and statements.

The program comes with a primer that walks you through basic accounting principles and a tutorial with sample data. It also features automatic transaction posting and pop-up customer, vendor, employee, job, account, and inventory lists. The package supports both accrual and cash-basis accounting and provides month- and year-end closings. You can link ACCPAC Simply Accounting data with your word processor and spreadsheet documents that support DDE.

$199
Computer Associates International, Inc., Islandia, NY; (516) 342-5224; fax: (516) 342-5329
Circle 1197 on Inquiry Card.

Kiplinger's CA-Simply Money

Computer Associates combines financial advice from the publishers of *Kiplinger's*, the personal finance magazine, with point, click, drag, and drop features. You can get advice on mortgages, refinancing, investments, payroll for household help, college tuition, retirement, taxes, and general debt. Kiplinger's CA-Simply Money offers advice from *Kiplinger's* on every move and transaction you make.

Kiplinger's CA-Simply Money lets you set up separate, visible income sources such as paycheck, dividends, and business income. You can generate reports by pressing a button, customize and save more than 50 report types and dozens of graphs, print checks, and pay your bills electronically though Prodigy's BillPay USA.

$69.99
Computer Associates International, Inc., Islandia, NY; (516) 342-5224; fax: (516) 342-5329
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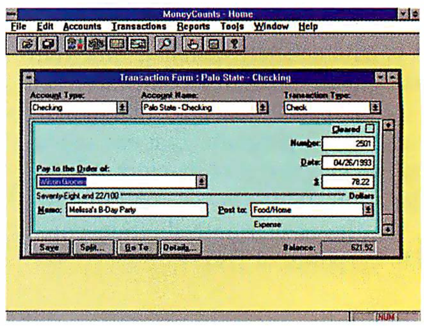
Money 2.0

Microsoft Money 2.0 is based on a checkbook-style design and includes tax, budget, and loan analysis capabilities. The charting feature allows you to view trends in your income and expense categories, compare budget versus actual spending, see pie charts of asset allocations, and more. Transaction Coaches are like having a personal trainer for your finances, according to Microsoft. A calculator lets you convert foreign and local currencies. A loan calculator is also included, along with an automatic budgeting feature.

$69.95
Microsoft Corp., Redmond, WA; (206) 882-8080; fax: (206) 936-7329
Circle 1199 on Inquiry Card.

MoneyCounts for Windows

MoneyCounts for Windows, from Parsons Technology, uses a checkbook analogy for its screens to manage cash, checking, credit cards, and savings. Designed for home or small business use, the program handles an unlimited number of transac-



tions and accounts for organizing daily finances and tax documents.

Some features are the ability to create multiple sets of books, the ability to choose single- or double-entry accounting, support for nonprofit and for-profit organizations, and more. An on-line facsimile of the 1040 tax form is included, as well as an address book that enables you to build a

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It's your choice. A little more than 50 percent of all business software in use today is pirated.

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(800) 688-BSA1 (2721)

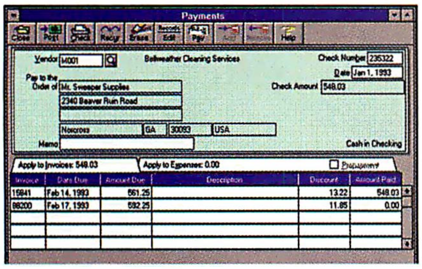
BSA Business Software Alliance

database of names, addresses, and phone numbers you can merge with your transactions for generating checks. The package exports data to the tax package Personal Tax Edge and the spreadsheet ProCalc 3D from Parsons Technology.

$49
Parsons Technology, Hiawatha, IA; (319) 395-9626; fax: (319) 393-1002
Circle 1200 on Inquiry Card.

Peachtree Accounting for Windows Release 2

Peachtree Software calls this package "accounting for the beginner" and simplifies



it with graphics guides, a setup checklist, and on-line tutorials. A "Friendly Accountant" walks you through setup and installation, and there are Smart Guides that explain data fields.

Peachtree Accounting provides general ledger, accounts receivable, accounts payable, payroll, inventory, job/project tracking, financial report writer, forms design, bank reconciliation, and import/export modules.

According to Peachtree, the Manager's Series assists small businesses in making decisions. The software offers interpretations and graphical overviews of your cash flow, collections, and payment status. Peachtree Accounting supports OLE and DDE, and the new version uses MDI, giving you the ability to display multiple reports at once.

$169
Peachtree Software, Norcross, GA; (404) 564-5700
Circle 1201 on Inquiry Card.

QuickBooks 1.0 for Windows

Intuit's QuickBooks provides invoicing and sales, accounts receivable, bill paying and accounts payable, checking accounts, reports, graphs, project and job tracking, payroll, and inventory modules.

Reimbursable expense tracking lets you automatically bill customers for expenses. QuickFill is a feature that eliminates repetitive data entry by filling in information from your business lists as well as recalling previous transactions. The QuickZoom feature enables to you zero in and see the information behind the numbers in your reports.

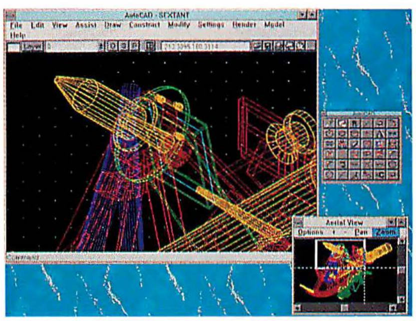
The package comes with preset reports. You can create instant reports using the new QuickReports feature, according to Intuit. Graphs give you a graphical view of the results and financial status of your business. Qcards provide instruction on all features of QuickBooks.

$159.95
Intuit, Menlo Park, CA; (415) 322-0573
Circle 1202 on Inquiry Card.

SCIENTIFIC & ENGINEERING

AutoCAD Release 12

Autodesk says it developed the Windows version of AutoCAD to make it easier for people to use CAD tools for the first time. Features of the Windows AutoCAD include a new graphical interface, accelerator keys, enhanced Clipboard support, support for multiple sessions, OLE support, and drag-and-drop functions.



You can start drawing and editing by clicking on an icon button. The new feature set includes the ability to do 2-D and 3-D design, links to several databases, and the Advanced Modeling Extension, which is an optional module for solid modeling, integrated color rendering, network licensing, and printing and plotting.

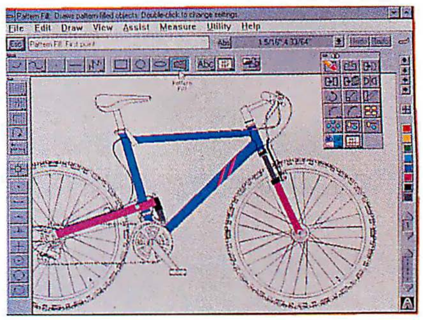
To run AutoCAD release 12 for Windows you need Windows 3.1 or higher, 8 MB of RAM, and a math coprocessor.

$3750
Autodesk, Inc., Sausalito, CA; (415) 332-2344; fax: (415) 331-8093
Circle 1203 on Inquiry Card.

AutoSketch

AutoSketch for Windows is an illustration tool designed for people doing technical illustration, architectural drafting, and engineering drawings. The program features SketchTools, a combination of custom toolboxes, icons, and macros that automate command sequences.

Drawing tools include a set of measurement tools and associative dimensioning ability, which updates dimensions automatically when you change a distance or angle. You can display drawings in dec-



imal units accurate to six places, or in feet or inches.

AutoSketch for Windows supports the DXF file format, which enables you to import and export drawings from CAD programs. The package also supports OLE and DDE.

$299
Autodesk, Inc., Bothell, WA; (206) 487-2233; fax: (206) 483-6969
Circle 1204 on Inquiry Card.

CADvance 6.0 for Windows

CADvance is a CAD program that features TrueType font support and editing, including paragraph text, dimensions, guilding grids, attribute text, and more. A new paper space environment feature lets you work in the actual size of the final printed or plotted output. CADvance supports OLE.

An improved attribute database interface includes the automatic generation of relational database files and index files. A

properties selection dialog box lets you select objects in a drawing by any combination of drawing location, color, layer, object type, attribute key, and other characteristics. The new version of CADvance supports Microsoft's ODBC standard for SQL queries.

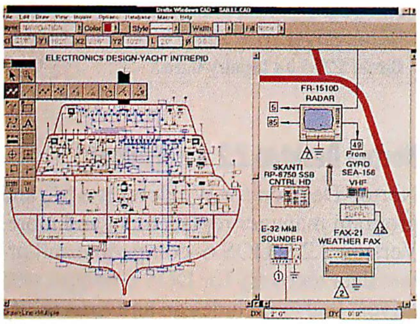
$1995
Isicad, Anaheim, CA; (714) 533-8910; fax: (714) 533-8642
Circle 1205 on Inquiry Card.

Drafix Windows CAD

This package, from Foresight Resources, aims to simplify computer-aided design and drawing. With it you can move, copy, rotate, mirror, extrude, change text fonts or size, move dimension text and extension lines, move the endpoints of a line, and more.

Editing is done at the CAD Edit Bar or by using the Selection Modifier that lets you pick a combination of entities by almost any characteristic.

The package has drawing features, as-



sociate dimensioning ability, a library of over 400 symbols, a background redraw feature, and more. You can import or export CAD drawings in AutoCAD DXF or IGES format, and you can read and write files in the HPGL and Windows Metafile formats for compatibility with Micrografx or Corel files.

$495
Foresight Resources Corp., Kansas City, MO; (816) 891-1040
Circle 1206 on Inquiry Card.

Mathcad 4.0

The latest version of this engineer's tool features SmartMath, a rules-based processor that MathSoft says makes numeric and symbolic calculations faster and more accurate. SmartMath provides an intelligent interface between the user's problem and Mathcad's numerical and symbolic capabilities. SmartMath reviews your input and executes a strategy for solving the problem by writing a new set of equations in a pop-up window. It also delivers the results to the Mathcad document. SmartMath comes with Symbolic/Numerical Optimization and Live Symbolics modules. Other SmartMath add-ons will be available in the future, according to MathSoft.

Mathcad 4.0 runs under Windows 3.1 as a 32-bit application. According to MathSoft, it runs twice as fast as the previous version and lets you manipulate a virtually unlimited amount of data arrays simultaneously.

Version 4.0 supports OLE as both client and server so you can transfer data and graphics between Mathcad and other OLE-aware applications.

$495
MathSoft, Inc., Cambridge, MA; (617) 577-1017; fax: (617) 577-8829
Circle 1207 on Inquiry Card.

Mathematica 2.2 for Windows

Mathematica handles numeric, symbolic, and graphical computations and has a built-in programming language. You can use it as a numeric and symbolic calculator, a visualization system, a programming language, a modeling and data analysis environment, a knowledge representation system, or a control language.

Mathematica 2.2 for Windows contains new front-end features that enhance interactive document capabilities, according to Wolfram Research. The new version can recognize sparse linear systems. Equation solving has also been improved, Wolfram says, and interval arithmetic capabilities have been added. The program's symbolic capabilities include more sophisticated treatment of singularities in definite integrals, according to Wolfram Research. It can also generate symbolic solutions to systems of nonlinear ordinary differential equations, additional Ricatti equations, and first-order partial differential equations.

$595
Wolfram Research, Inc., Champaign, IL; (217) 398-0700; fax: (217) 398-0747
Circle 1208 on Inquiry Card.

Systat for Windows

Systat for Windows is a general-purpose statistical program that lets you analyze and manipulate data with a comprehensive range of statistical procedures. Quickstat buttons give you single-click shortcuts to common statistical analyses. You can view output on-screen and then cut, copy, or paste it to other Windows programs.

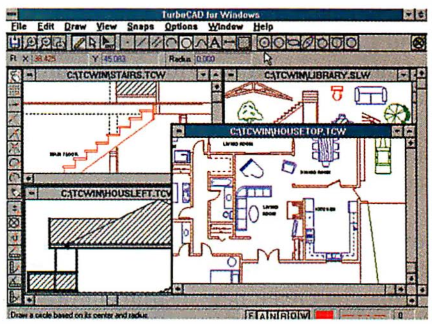
Graphics tools, such as the lasso, let you select a subset of data, exclude outlying points, and then create a graph of just the subset. You can assign different plot symbols to differentiate subsets. You can also rotate plots to view data from different perspectives.

Advanced procedures include the ability to perform multivariate analysis of variance and nonlinear regression. Systat for Windows also offers a range of cluster analysis methods, factor analyses, multidimensional scaling, nonparametric statistics, and canonical correlations.

$895
Systat, Inc., Evanston, IL; (708) 864-5670; fax: (708) 492-3567
Circle 1209 on Inquiry Card.

TurboCAD for Windows

TurboCAD is a CAD package designed for novice and professional users, according to International Microcomputer Software. With TurboCAD you have access to all draw, edit, and snap functions by clicking on icons. Other features include MDI, automatic double-line drawing,



spline and Bézier curves, unlimited pan and zoom, 500 symbols with 19 libraries, a choice of icons, and support for DXF, HPGL, and ASCII file formats.

$149.95
International Microcomputer Software, Inc., San Rafael, CA; (415) 454-7101
Circle 1210 on Inquiry Card.

Vellum 3D for Windows

Vellum 3D is a professional design and drafting package with the patented Geometric Inference Engine at the heart of the new Windows version. This enables the new Drafting Assistant, which automates geometric alignments.

With Vellum 3D, you create a 3-D model. Then, with a single mouse click, four associate views (isometric, front, right, and top) are created automatically. An on-screen trackball lets you visualize designs from any point in space, and changes in any aspect of the design in any view are updated automatically in other views. Vellum 3D for Windows includes NURBS and advanced parametric capability. Ashlar offers the same functions across PC and Mac platforms.

To run Vellum 3D for Windows you need Windows 3.1 and 5 MB of RAM.

$2995
Ashlar, Inc., Sunnyvale, CA; (408) 746-1800; fax: (408) 746-0749
Circle 1211 on Inquiry Card.

WaveTest VIP

WaveTest VIP is a test program software tool that lets you add GPIB, VXIbux, MXIbus, or RS-232 instrument control and data acquisition to any Windows-based test development program. It also provides interactive instrument simulation.

WaveTest VIP can be used in C, C++, Turbo Pascal, or Visual Basic programming environments or with application environments such as Excel, SuperBase IV, and Lotus 1-2-3. Under these environments, when you need to add instrument control and data acquisition, you select the instrument from WaveTest VIP and choose its function from the graphics instrument control panel.

WaveTest VIP comes with a library of over 250 drivers for instruments from more than 30 vendors and includes a utility that helps you create new instrument drivers for any GPIB, VXIbus, or RS-232 instrument. Drivers handle set-up, read delays, data-string parsing, and SRQ interrupts. A panel editor lets you develop user interfaces, data display panels, and reports. Also provided is an active bus traced for program editing and debugging.

$695
Wavetek Corp., San Diego, CA; (619) 279-2200; fax: (619) 565-7942
Circle 1212 on Inquiry Card.

UTILITIES

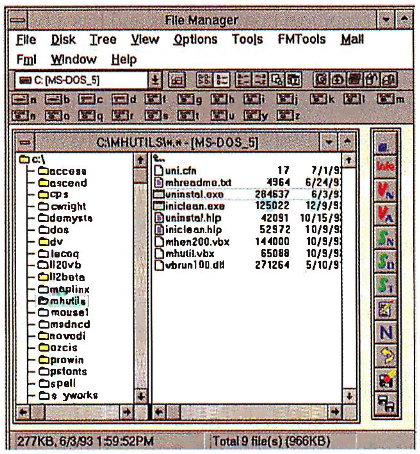
Cursorific Professional 3.0

Designed for use with notebook computers, Cursorific Professional solves the hard-to-see cursor problem, Aapex Software says. You can set different cursor images for stationary and moving cursors, and you can animate the cursor as well. You get over 60 animated cursors and 400 cursor images. A cursor image editor lets you draw your own cursors or use import options to pull one in from your paint program. The Big DOS Cursor is a utility that turns the blinking underbar into a full-size blinking block for DOS applications.

$49
Aapex Software Corp., Sparks, NV; (702) 324-4580; fax: (702) 324-4578
Circle 1213 on Inquiry Card.

FMTools

FMTools is a Windows File Manager replacement. It adds new features and functions that make File Manager easier to use and more flexible, according to Micro-



Help. You can add a new menu item to the File Manager menu and up to 12 selections under that menu. If your application lets you use filenames as command-line parameters, you can tell FMTools to use the filenames you've selected in File Manager. If you need to know how much space a group of files or directories takes on your hard disk, you can use FMTools' Get Info box. FMTools also has a file browser that lists the contents of any ZIP file. You can use FMTools as a program launcher, as well. Just drag any file from the Windows 3.1 File Manager window and drop it on the button bar.

$79
MicroHelp, Inc., Marietta, GA; (401) 516-0899; fax: (404) 516-1099
Circle 1214 on Inquiry Card.

Golden Retriever 2.0b

Golden Retriever organizes any file by project or subject into on-screen file drawers and folders. It allows you to use filenames up to 256 characters long. When you open a file folder in a drawer and double-click on the name of a document, Golden Retriever launches the applications used to create that document and opens the file.

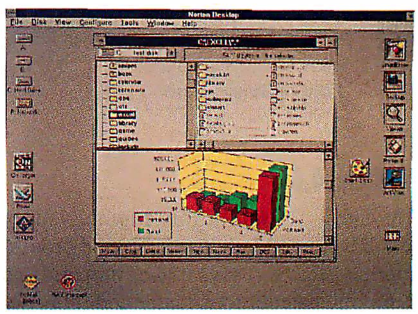
Version 2.0b has new commands that intercept file save and open operations in other Windows applications, so you can work in any Windows program, creating and saving multiple documents without exiting to Golden Retriever. Also added is a version control field, which creates an audit trail of document revisions.

$99
Above Software, Inc., Irvine, CA; (714) 851-2283; fax: (714) 851-2285
Circle 1215 on Inquiry Card.

Norton Desktop 2.2 for Windows

Norton Desktop for Windows is a file and program manager replacement and more. Version 2.2 is DOS 6–compatible and offers data recovery for DOS 6 compressed drives. It also includes an antivirus utility that Symantec says detects more than 1500 viruses. A backup utility supports Colorado Memory Systems and Iomega tape systems. Additional utilities include three calculators, a text editor, and the Batch Runner Technical Reference.

The utility supports all major network operating systems, according to Symantec. The optional Network Menuing



Administration Pack gives you Windows menuing across a client/server network.

$179; Network Menuing Administration Pack, $295 per server
Symantec Corp., Cupertino, CA; (408) 253-9600; fax: (408) 253-4092
Circle 1216 on Inquiry Card.

PC Tools for Windows

PC Tools for Windows comes with 14 modules. MultiDesk organizes your work and provides simpler file access, according to Central Point. It lets you install several virtual desktops, each with all the applications and files related to a specific task. File Manager has 80 file viewers, which let you display text and graphics files in their native format without loading the host application. SmartFind is a text search utility. WinShield provides a Windows-based disk repair tool. Optimizer optimizes your hard drive from within Windows. System Consultant analyzes and offers more than 400 reports on hardware and software aspects of your system. It also makes more than 50 recommendations to help you achieve peak efficiency out of your setup. PC Tools also includes the PKZip file compression and decompression utility.

$179.95
Central Point Software, Inc., Beaverton, OR; (503) 690-8090; fax: (503) 690-8083
Circle 1218 on Inquiry Card.

UnInstaller

MicroHelp's UnInstaller cleans up Windows by removing an application and the bits and pieces left behind (e.g., references in WIN.INI, changes to SYSTEM .INI, application INI files, and data files with extensions listed in WIN.INI.) UnInstaller uses what MicroHelp calls Smart Decoy Technology, which lets you remove applications from a network's server and workstations. When a system administrator uninstalls a program, UnInstaller leaves a decoy copy of itself on the server, so when users try to run the application, it offers to clean up their application, too.

$79
MicroHelp, Inc., Marietta, GA; (401) 516-0899; fax: (404) 516-1099
Circle 1219 on Inquiry Card.

More Windows 3.0

More Windows replaces your standard Windows EGA or VGA driver with its own, which fools Windows into seeing a larger number of pixels, creating a working screen of up to 1024 by 1024 pixels. When you're working in Windows applications on a small screen, you can bump the edge of the Window with your mouse and the screen area will grow. More Windows screen drivers use the display card's memory; they don't use the computer's RAM.

$99
Aristosoft, Inc., Pleasanton, CA; (510) 426-5355; fax: (510) 426-6703
Circle 1217 on Inquiry Card.

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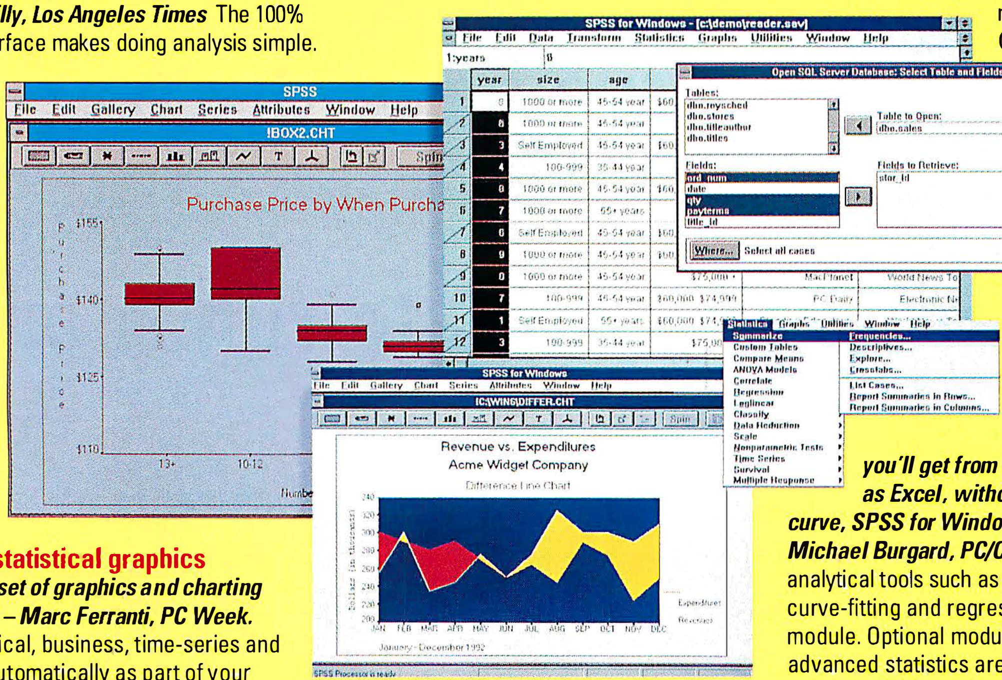
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"Stumbling blocks to statistical analysis are eliminated with SPSS for Windows. You don't have to be a programmer to use it and you don't have to be a statistician to understand it." – Richard O'Reilly, Los Angeles Times The 100% Windows interface makes doing analysis simple. Context-sensitive help and an online glossary of statistical terms are just a click away.

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"For more statistical analysis tools than you'll get from a spreadsheet such as Excel, without the steep learning curve, SPSS for Windows is a great buy." – Michael Burgard, PC/Computing Widely used analytical tools such as crosstabs, correlations, curve-fitting and regression are in the Base module. Optional modules with unrivaled advanced statistics are available. You won't outgrow of this package.

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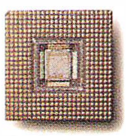
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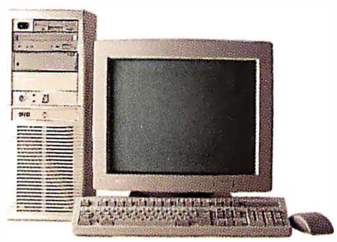
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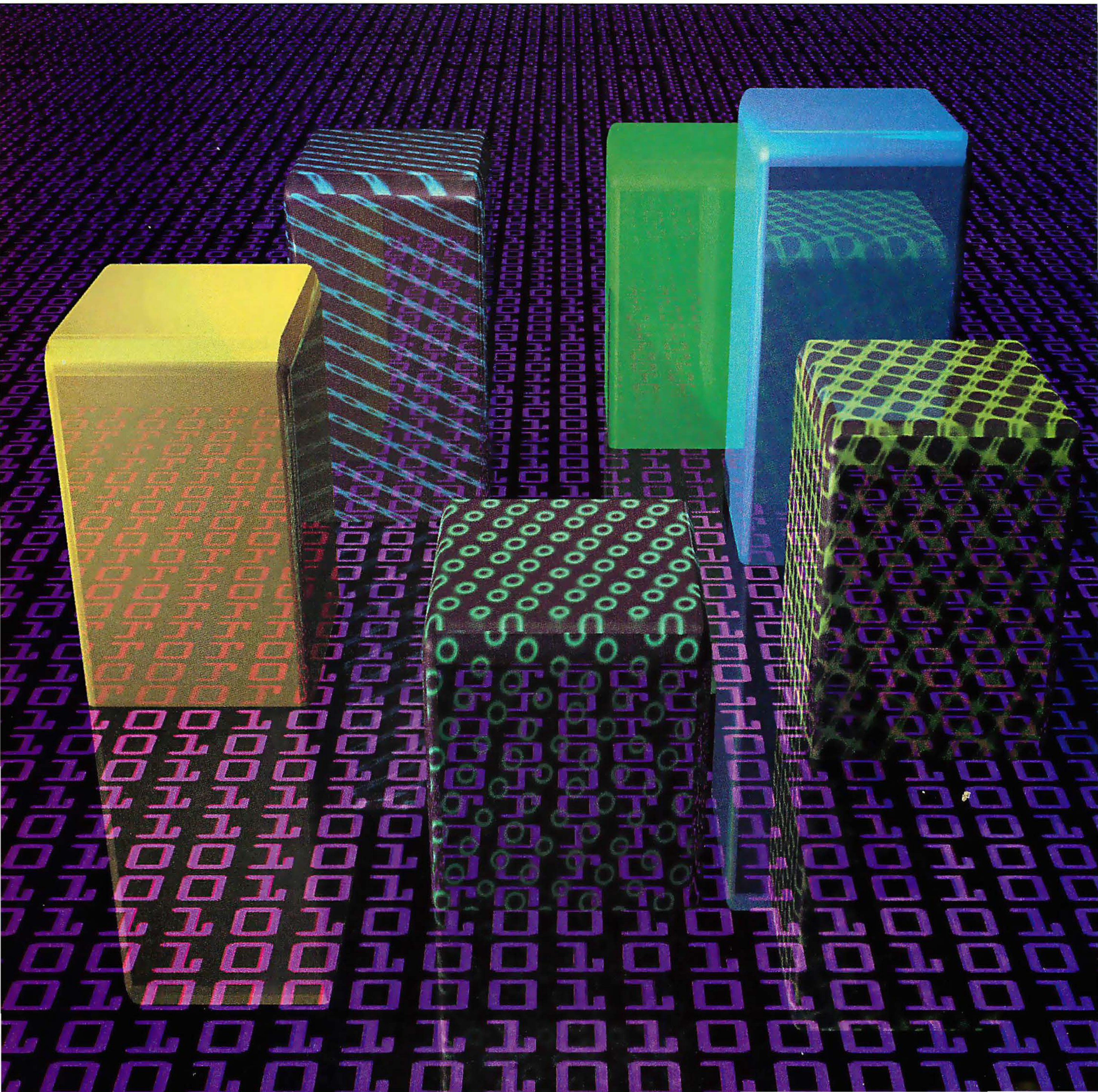

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State of the Art

THE POWER OF GRAPHICS

The growing sophistication of computer graphics for GUIs, videoconferencing, and 3-D is made possible by some very advanced technologies

JOHN BRYAN AND BOB RYAN



In the history of computer graphics, time is divided into two eras—pre-Mac and post-Mac. Before the introduction of the Apple Macintosh in January, 1984, graphics were an expensive luxury for most desktop computer users; something you bought only if your application demanded it.

The Macintosh changed all that. It showed how you could use computer graphics to create an abstract environment that was accessible—indeed easy—for mere mortals to manipulate. In the case of the Macintosh, of course, the environment abstracted is your personal computer. The windows, menus, and icons that populate Macintosh, Windows, NextStep, Motif, and other GUI-based desktop computers are readily understood abstractions of programs and files that exist as bits on your computer's hard drive and in your computer's memory.

Today, computer graphics are bringing the power of abstraction to bear on many problems beyond the operation of your personal computer. Research scientists use sophisticated graphics to visualize both the small and the large. The former is best represented by the use of computer graphics in molecular modeling. (The days when a Watson and Crick would have to rely on hand-built metal models to test their theories are gone forever.) The latter recently made headlines when scientists used computer graphics to discover that the Andromeda Galaxy (M31) has a double nucleus, a finding that theoretical astrophysicists may take a while explaining.

Computer graphics are having an enormous impact beyond GUIs and the rarefied worlds of molecular biology and theoretical physics. They are used to simulate environments as diverse as the core of a nuclear reactor, the cockpit of a high-performance fighter, the interior of your next house, or the inhabitants of a Jurassic-era grassland. Increasingly, they are also being used as a substitute for air and ground transportation by bringing people together via videoconferencing rather than in person. The technologies behind graphics advances—from faster GUIs to the creation of realistic 3-D simulations—range from new data pathways on desktop machines to multigigaFLOP dedicated processors on Unix workstations. Fortunately, they all have one goal: to make ever-more powerful computer-generated abstractions that make our jobs and lives a little easier.

Taking the Fast Path

For desktop computer users, the most important advance in computer graphics has been local-bus video. Local bus describes a fast pathway between a processor and a peripheral such as a video card, especially when coupled with the new breed of video adapters that accelerate GUI operations in hardware (see "Inside Windows Accelerators" on page 229).

The first local-bus implementations were developed to service graphics data. They were also proprietary; your system came with whatever local-bus graphics capabilities that manufacturers (e.g., Dell) put on the motherboard. By 1991, however, the industry came to realize the importance of adopting a standard for local buses that would let you both upgrade your graphics and let other peripherals such as drive controllers take advantage of the speed of the local-bus interconnect. Of course, instead of adopting a single standard, the industry has adopted two.

The VESA standard local bus, published by the Video Electronics Standards Association, is an adaptation of the 486's own bus structure. It is the most popular local-bus choice of PC-compatible computer makers. Intel's PCI (Peripheral Component Interconnect) local bus also supports high-speed graphics applications, along with other types of direct CPU-to-peripheral operations.

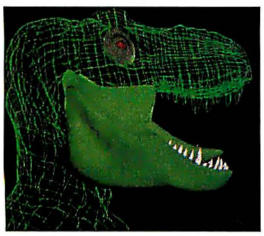
Both the original VESA and PCI specifications described 32-bit buses (see "Fast Transit," October 1992 BYTE), but both have raised the ante to coincide with the introduction of the next generation of processors with 64-bit processors, which include the Intel Pentium, the DEC Alpha, and the Mips R4000. As these processors are destined to run today's graphics-intensive operating systems, superior graphics performance is going to be essential.

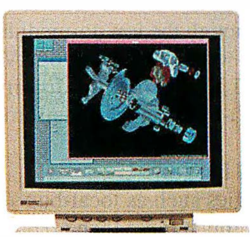
At a resolution of 640 by 480 pixels and 24-bit color, a single screen goes through over 7 million bits per iteration. This is obviously well beyond the capabilities of either the ISA or EISA bus, and, indeed, it starts to strain the 32-bit bus implementations. But both the 64-bit VESA and PCI 2.0 offer theoretical performance of up to 250 MBps, sufficient bandwidth for just about anything in the foreseeable future.

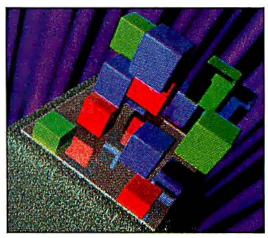
The VESA-64 specification is the second generation of local bus to come from the 170 voting members of VESA. With the 64-bit implementation, VL-Bus now stands ready for the next generation of Intel processors. Perhaps the only limiting factor on VL-Bus is that it is really ready only for Pentium, as opposed to other processor options that are encroaching on the previously "Intel-only" PC market.

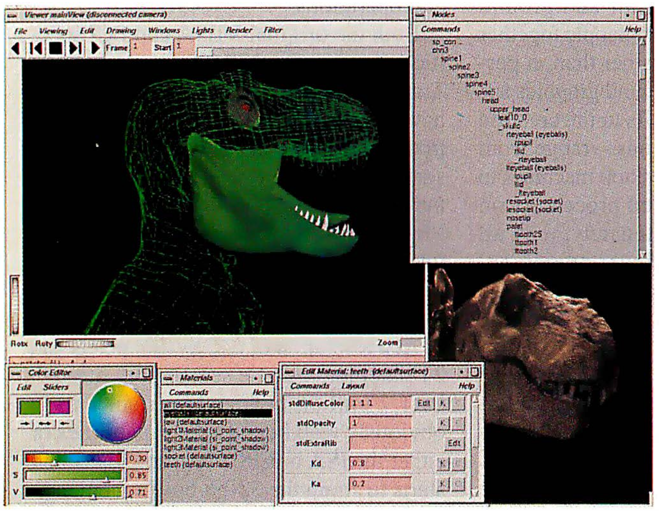
Because the original VL-Bus design closely followed the 486's own bus design, it was a relatively easy design specification to integrate into the PC. VL-Bus is a true local bus, directly connected to the processor. This offers both advantages and disadvantages.

The two most significant advantages are that first, because VL-Bus is directly connected, transfers are not subject to a great deal of address-decoding and bus-timing overhead. Applications that generally use several small transfers, rather than extended bursts, tend to perform better on









Computer graphics *let you see what usually can't be seen. Sophisticated modeling programs and interactive 3-D graphics give us the best view we will ever have of Tyrannosaurus rex and other out-of-reach phenomena such as subatomic particles and quasars. (Courtesy of Silicon Graphics, Inc.)*

VL-Bus than on PCI.

Second, the mechanical specification of VL-Bus calls for an in-line bus connector. This means that cards can be produced that take advantage of both the local bus and the slower system I/O bus. This results in lower overall system costs, because more functions can be integrated onto a single expansion card.

The obvious disadvantage is that to run VL-Bus in non-Intel-compatible systems, it must be bridged, which negates the advantages. Nonetheless, you can use VL-Bus with an R4000 or an Alpha, but no one seems to be jumping at the possibility. Another disadvantage is that the 486 local bus was never designed to drive a lot of devices, so the number of slots available to VL-Bus will always be small, without a bridge in place.

Unlike VL-Bus, PCI was designed to be relatively independent of processor type and, in fact, will be integrated into the second generation of DEC Alpha chips, due sometime in the fourth quarter of this year. (Considering the availability of the first generation of Alpha processors, expect the second generation later rather than sooner.) PCI is a mezzanine bus, rather than a true local bus, and it has to be bridged to any processor, including Intel's own.

Because of translation issues, the bridge takes its toll in performance, but in burst transfers, PCI can deliver approximately the same throughput as VL-Bus. The dividend a bridged bus provides is independence for (and from) the CPU. With PCI, the CPU (or multiple CPUs) can be working in the background as PCI bus masters use the PCI bus for their own purposes.

Both VESA-64 and PCI 2.0 use multiplexed address and data lines to transmit 64 data bits. VESA-64 is still an in-line connector with respect to the I/O bus, while PCI's connector is positioned parallel to the I/O connectors. The result is that PCI boards will not be able to take advantage of standard I/O functions concurrently with local-bus activities, which means higher overall system costs.

One primary advantage of PCI is its automatic configuration feature. With VL-Bus, add-in cards are transparent to the operating system and software, unless the software is looking for a specific function, which can result in incompatibilities. With PCI, in a similar fashion to EISA, the system looks at the bus and identifies the cards installed, transparently with respect to the user. This allows for optimization by the system and increased performance in certain functions.

These features come at a cost, however. Implementing PCI in the first place is more expensive than VL-Bus, and expansion cards will also probably cost somewhat more. Between the cost, design, complexity, and adaptability issues, it looks as though the low-to-medium range of system vendors will adopt VL-Bus, while PCI will probably dominate the medium-to-high range of platforms.

Real-World Images

Technologies such as local-bus video are useful for much more than GUI acceleration. In conjunction with new classes of video hardware, they are bringing real-world graphics, in the form of still images and motion video, to the desktop.

One of the linchpin technologies that is making digital manipulation of real-world images viable for desktop machines is digital signal processing. In many cases, a DSP (digital signal processor) is better suited than general-purpose processors to the types of operations that graphics images demand. Specifically, DSPs are designed to accelerate the multiply/add operations that are the heart of many image-processing operations.

Major firms such as Intel, Microsoft, Texas Instruments, IBM, Compaq, and Dell are in the process of migrating DSP technology to desktop computers. Apple is already shipping its new Mac AV series with their built-in DSPs. Applications running on a Mac AV can use the DSP to process video and other types of real-world information.

One company active in bringing DSPs to the desktop is Analog Devices. As part of its Signal Computing initiative, Analog Devices has developed SCOPE, the Signal Computing Operating Environment. In essence, SCOPE provides an API and a hardware abstraction layer, or HAL, that allows applications developers to get at the power of a DSP without having to deal with its internal complexity. The API offers a standard interface that programmers can use to call the services of hardware, without regard for the actual hardware type. HAL provides access to the actual signal-processing hardware, which powers the application.

Because the DSP is a secondary processor, SCOPE includes HALs for both the CPU and the DSP to enable program developers to take advantage of both processors. The focus of SCOPE is the adoption of an open standard of development for applications. SCOPE supports both the Microsoft and OSI (Open Systems Interconnection) communications models so that standard Windows appli-

DSP vs. CPU

DSPs are specialized processors, while CPUs are more general. You wouldn't want to run Word for Windows on DSPs, but for image manipulation, they are ideal.

DSP	CPU
• accumulator-based architecture	• register-based architecture
• programmer-accessible caches	• transparent caches
• dual data buses	• single data bus
• optimized for multiply	• general-purpose instruction set
• accumulate operations	

cations can take advantage of the power of programmable DSPs.

Giga Operations uses SCOPE for its low-cost, parallel DSP board for desktop computer systems. Giga Operations' G-200 and G-800 boards use Analog Devices' 2105 DSPs, together with 1 MB of DRAM and a Xilinx PGA (Programmable Gate Array) in a single surface-mount module called Scalable Intelligent Image Module, or SIIMOD. Giga Operations is targeting the image-processing market. With the programmable SIIMODs, the G-200 can deliver a performance of up to 200 MIPS for video-effects applications—10 to 30 times the performance available from other conventional accelerators in dedicated systems—and at significantly lower costs. As a bonus, because of the programmable nature of DSPs, in general, and of SIIMODs, in particular, the G-200 and G-800 are adaptable to a wide variety of applications other than image processing.

The Codec Question

Perhaps the fastest-moving area of computer graphics today is full-motion video. From interactive CD-ROMs to videoconferencing, full-motion video promises to be one of the most important data types of the 1990s.

At TV resolutions and frame rates, full-motion video requires an enormous amount of storage and transmission bandwidth—far beyond the capabilities of present or near-future storage and communications technologies. Because of the demands it places on a system, video data must be compressed before you can use it as a data type on a computer system or a network.

The job of compression falls to the video codec. Video codecs use several different technologies to remove redundancy from video signals to make the individual frames more digestible and then to reconstruct the frames for playback. Thus, they are pivotal in bringing full-motion video to the desktop. The problem isn't that good codecs don't exist, but that too many do.

Take, for example, Microsoft's Video for Windows, which incorporates three different codecs that can either be implemented in hardware or software. Video for Windows is also extensible so that you can add still other codecs to your system.

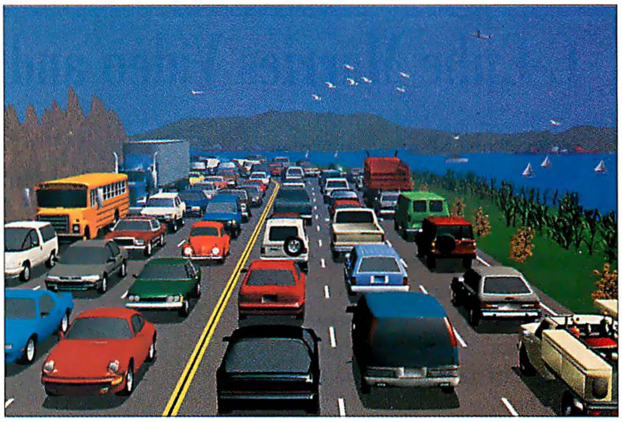
The reason several codecs exist is that different video applications have various resolution and frame-rate requirements. Some applications just need SIF (Source Input Format) resolutions (360 by 240 pixels) while others require broadcast-quality CCIR 601, the 720- by 480-pixel digital studio standard. Often, the codec used depends on the capabilities of the hardware system.

For example, interactive CD-ROM applications are limited by the 1.5-Mbps data transfer rate of CD-ROM players. To provide full-motion video from such devices, you must sacrifice frame rate or resolution, or both. Companies like Philips and 3DO adopted the codec standard MPEG 1 for CD-ROM playback. MPEG 1 provides SIF resolution at CD-ROM playback rates.

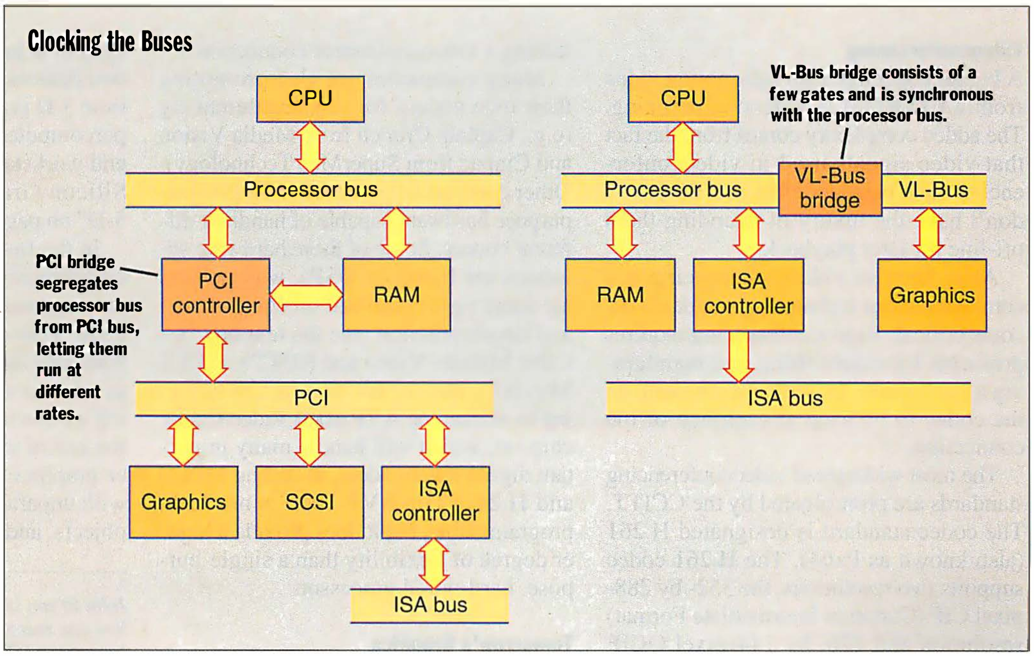
MPEG 2 is designed to handle applications (e.g., video on CD) that need higher-quality playback. MPEG 2 supports CCIR 601 resolutions, but it requires transmission rates above 4 Mbps, as opposed to the 1 to 3 Mbps that MPEG 1 requires. It also requires a lot more processing time to encode the source video signal.

Some codecs can adapt to different environments. For example, Intel's Indeo runs on 386 and compatible platforms. Indeo is adaptive in the sense that the software recognizes the basic capabilities of the underlying hardware, which may be a simple 386 or Intel's 750 video coprocessor, and adjusts the playback to the size, definition, and frame rate to which the hardware is best suited.

continued



Perhaps the most important role *for computer graphics is in modeling the mundane. Real-time 3-D animations are being used to investigate subjects as diverse as traffic congestion and architectural visualization. (Courtesy of Sun Microsystems Computer Corp.)*

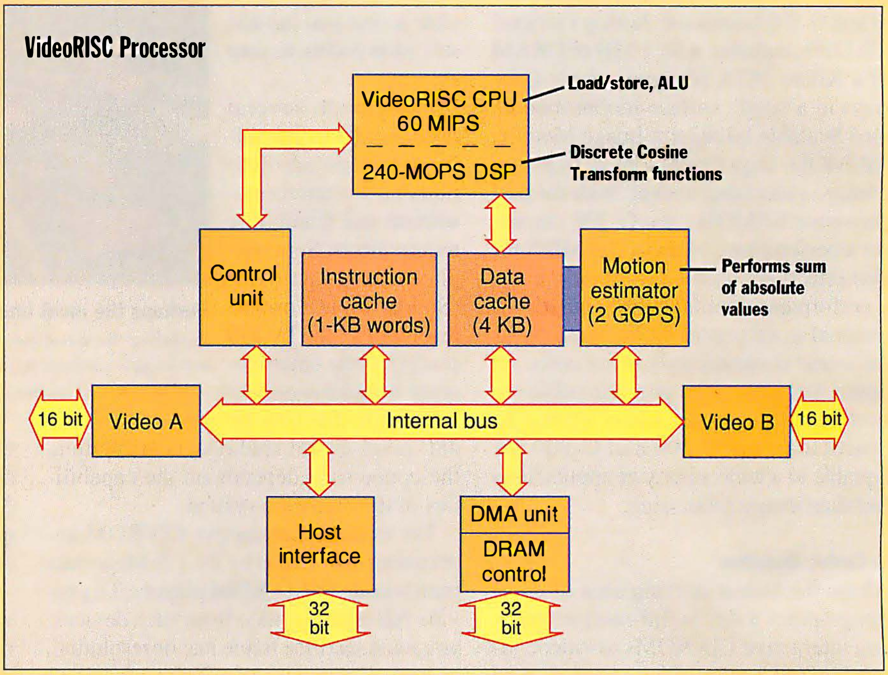


VL-Bus *requires a simple bridge to the processor bus, allowing it to run synchronously with the processor. PCI has a complicated bridge and runs asynchronously.*

C-Cube Marries Video and RISC

C-Cube Microsystems plans to bring silicon to bear to all types of full-motion video applications through its VCA (VideoRISC Compression Architecture). The core of VCA is the VideoRISC compression processor, which can handle many different compression algorithms.

The VideoRISC processor contains 1.2 million transistors on a 225-square-millimeter die. It consists of a number of functional units including a five-stage processing pipeline optimized for real-time video applications, a DSP unit for performing functions such as DCT (Discrete Cosine Transform), and a motion estimator that can perform up to 2 billion operations per second. These operations help determine differences in one frame from the previous or following frames.



The functional units *of the VideoRISC processor are designed to perform the types of computations required by compression and decompression algorithms.*

In addition to being programmable, which allows the VideoRISC processor to handle different codec standards, such as JPEG, MPEG 1 and 2, and H.261, it is also scalable. For example, you can use eight processors in parallel to encode NTSC video signals in real time, using the MPEG 2 codec. Two processors will suffice to encode using MPEG 1 in real time. In the future, C-Cube plans to produce both high-quality and low-cost versions for videoconferencing markets using H.261.

Videoconferencing

A bigger challenge than full-motion video from a CD-ROM is videoconferencing. The added complexity comes from the fact that video signals used in videoconferencing must be encoded in real time; you don't have the luxury of encoding them off-line for later playback.

Also, because videoconferencing is a communications technology, standards become critical. Videoconferencing requires protocols for establishing and maintaining a connection, as well as agreement on the codec to be used at each end of the connection.

The most widespread videoconferencing standards are promulgated by the CCITT. The codec standard is designated H.261 (also known as Px64). The H.261 codec supports two resolutions, the 352- by 288-pixel CIF (Common Intermediate Format) resolution and 176- by 144-pixel QCIF (Quarter CIF). Other CCITT standards define the protocols for setting up and maintaining a videoconference connection.

Many companies are also promoting their own codecs for videoconferencing (e.g., Captain Crunch from Media Vision and Cinpac from SuperMac Technology). Other companies are developing general-purpose hardware capable of handling different codecs. Some of these hardware solutions are based on DSPs, while others are more tightly focused on compression and decompression (see the text box "C-Cube Marries Video and RISC"). AT&T Microelectronics, for example, is bringing to market the AVP-1000 Video Codec chip set, which will handle many important digital video codecs, including MPEG and H.261. The AVP-1000 is not fully programmable, but it does provide a higher degree of flexibility than a single-purpose, hard-wired processor.

Tomorrow's Graphics

At their most sophisticated, computer graphics can pull entire worlds out of the ether or at least out of a database of polygon descriptions. In the past, sophisticated, real-time 3-D graphics was the province of supercomputers. Today, you find it in high-end workstations from companies such as Silicon Graphics (see "Three Ways to 3-D" on page 215). The trend here is clear.

In the future, real-time 3-D and videoconferencing capabilities will be available at a reasonable price to anyone who needs them. Your desktop computer will become your primary means of communication, as well as an invaluable tool for exploring a class of what-if possibilities beyond the ken of today's spreadsheets. Computer graphics technology will provide you with unparalleled access to complex data, objects, and entire systems. ■

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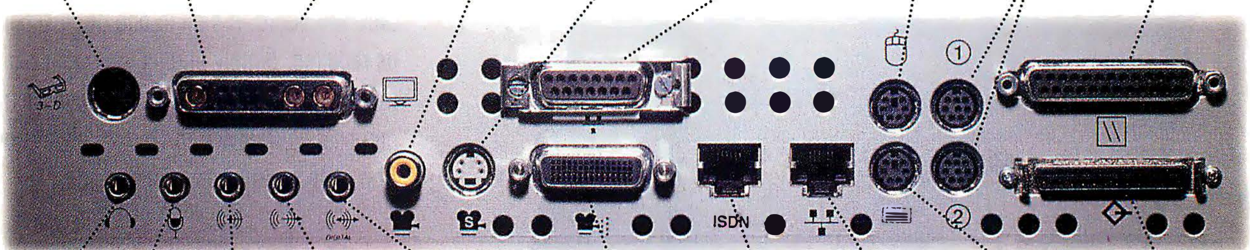
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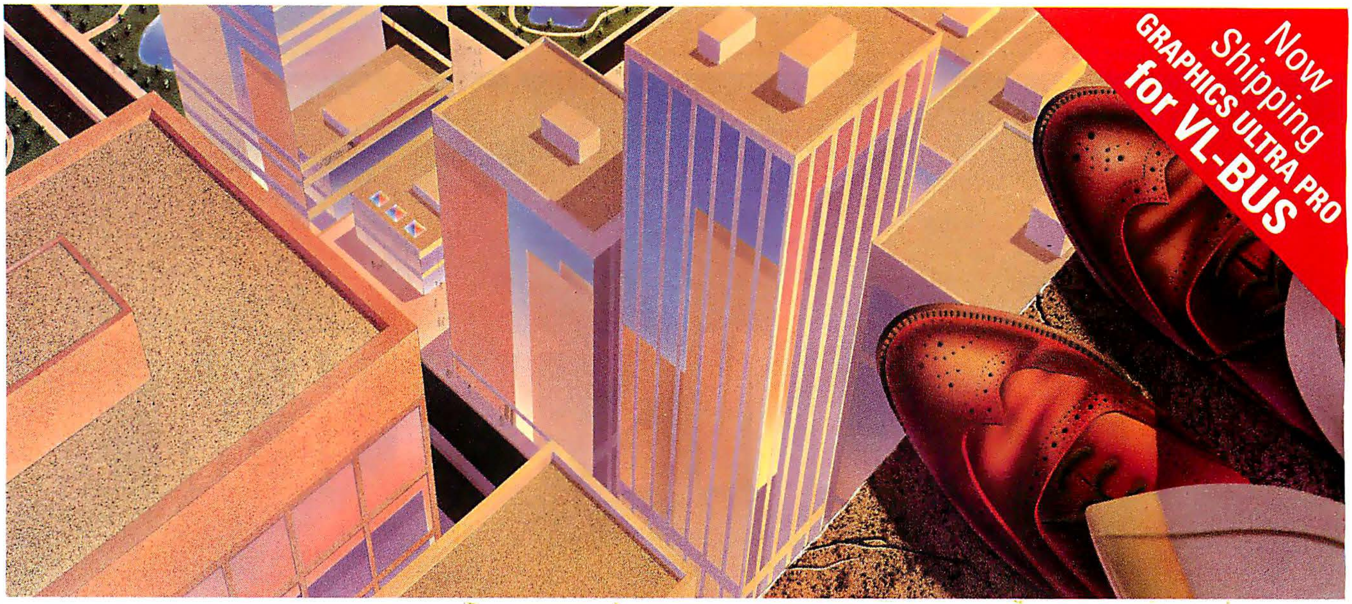
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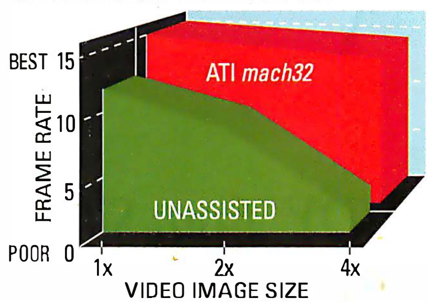
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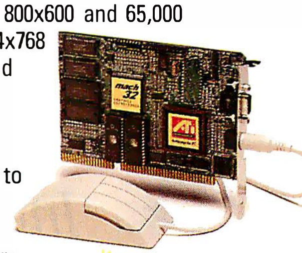
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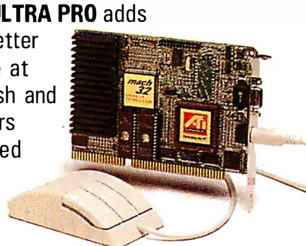
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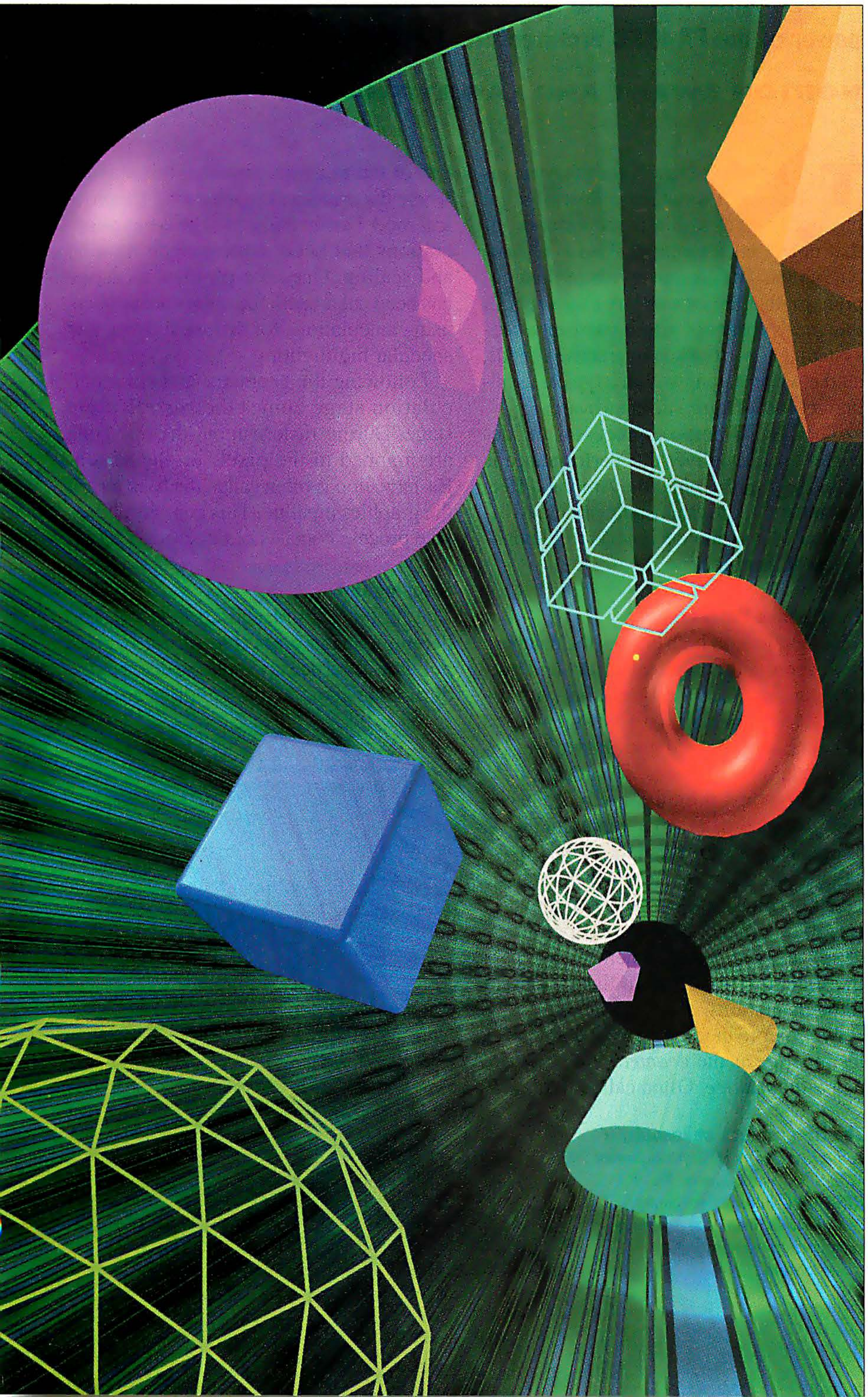
 [1]32-bit OS/2 2.1 drivers will be available in September 1993; 16-bit OS/2 2.1 drivers currently included. ATI drivers included in Windows NT package. [2]Tradeup plan to latest ATI products; call or fax for further information. [3]Suggested US retail prices, dealers may sell for less. [4]Mouse included with ISA versions only.

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State of the Art

THREE WAYS TO 3-D

All types of computer simulations from data analysis to virtual reality require 3-D graphics-rendering hardware that can create complex images in real time



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Like most computer-related technologies that capture the imagination of the general public, virtual reality has been hyped to the point of overkill. Nevertheless, the usefulness and economy of a technology that lets you explore the dynamics of an object or system built from polygon descriptions rather than from plastic and steel are beyond question. Once you understand the complexity of the many pieces that make up a virtual-reality system, you can better separate the hype from the reality of this interesting technology.

A flight simulator is the best-known example of such a system, where what you see on your screen changes in response to how you manipulate the controls of your virtual aircraft. The more the visual image created by the simulation resembles what you would see from the cockpit of a real aircraft, the better the simulation will succeed in conveying the experience of flying an airplane—without the risk of you crashing a multimillion-dollar machine, which would have nasty consequences for both you and the aircraft.

Behind the Scenes

The representation of virtual worlds—whether they reflect the fantastic or the mundane—presents great challenges to the designers of virtual-reality systems. By far the most common method used to represent such a world is as a collection of objects. These objects are programmed to react in a realistic way to the inputs you supply the system. To complete the feedback needed for a successful simulation, however, the system must also be able to visually represent the state of these objects in real time.

Thus, the heart of any virtual-reality system, or any computer-based simulation, is the graphics hardware that creates the images you view when you use the system. A successful system can create images so compelling that you will be hard

pressed to distinguish the real from the virtual.

Consider the work that a graphics subsystem has to do to animate 3-D objects. Working from a database that describes the objects, their position in a coordinate space, and their color and texture properties, the graphics subsystem has to create a bit-map representation of the objects, based on the position and orientation of the observer in the scene and the position, color, and intensity of any sources of illumination. For most general-purpose desktop machines, you measure the time it takes to render one frame of such an animation in hours. This is why real-time 3-D animation remains the realm of specialized hardware graphics engines.

Working with 3-D

The following articles describe 3-D graphics engines from Hewlett-Packard, Sun Microsystems, and Silicon Graphics, Inc. These subsystems represent three ways of tackling the problem of generating a visual representation of an object database. They vary because users require different capabilities and have different price sensitivities. In addition, they represent three different philosophies of creating 3-D images.

HP's 3-D graphics concentrates dedicated hardware on the most processing-intensive part of the pipeline used to create the images. By leaving front-end calculations to the system CPU, the HP graphics subsystem scales in performance as you move to better-performing CPUs.

On the other hand, the Sun and SGI systems use dedicated hardware for all aspects of the pipeline. Despite this, the Sun ZX graphics subsystems and the SGI RealityEngine² differ markedly in design and cost, as well as in the markets they address. Sun ZX graphics subsystems are far less expensive than the RealityEngine², thus giving more people access to 3-D graphics.

The SGI RealityEngine² is a masterpiece of hardware engineering. Like all masterpieces, it is expensive. It is designed for those people who need the best available 3-D graphics performance, regardless of cost.

Like all aspects of computing, graphics rendering is getting better, faster, and less expensive all the time. However, from the descriptions that follow, you'll find that it still takes a lot of technology to create the images of virtual worlds. ■

—Bob Ryan

HP Takes a Dual Approach

HP's graphics technology takes advantage of the ever-increasing power of the PA-RISC architecture. Here's how it works.

NORTON EWART AND LARRY THAYER

The job of a 3-D graphics subsystem is to convert a database describing a physical object into a representation of that object on the screen. This is a compute-intensive task that is rich in floating-point math and features large data sets. A designer's challenge is to implement a subsystem that performs at interactive speeds, all the while staying within a typical user's budget for 3-D graphics hardware.

The special-purpose processor the designer uses to deliver this performance is called a *graphics pipeline*. Among different graphics subsystems, the principal differences lie in the designer's implementation of this pipeline.

The Pipeline Process

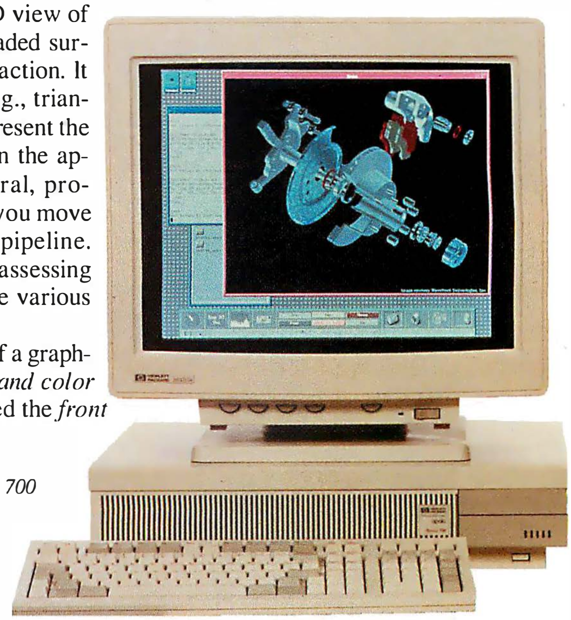
Your application both creates the database representing the physical object and provides an interface for interacting with the data. When you call for a 3-D view of the data, with lighted and shaded surfaces, the pipeline goes into action. It uses polygonal primitives (e.g., triangles and quadrilaterals) to represent the geometric form of the data in the application database. In general, processing demand increases as you move from left to right along the pipeline. This fact is important when assessing the trade-offs involved in the various implementations.

We refer to the first stage of a graphics pipeline as the *geometry and color calculation stage*. Often called the *front end* of the graphics pipeline, this stage is where the primitives representing the physical model are calculated. The types of operations that occur here include rotation and scaling. Once the physical structure has been calculated, the colors are applied, using calculations for diffuse lighting and specular highlighting.

Following the geometry and color calculation stage comes the *rasterization* stage. During rasterization, the polygons are mapped to the pixels on the screen. Rasterization is often called the *back end* of the graphics pipeline. This compute-intensive process consists of three major steps.

Stepping Out

The first step in rasterization is polygon decomposition and edge setup. Here, a polygon's vertices, which are determined during the geometry calculation, are used



The HP graphics philosophy *is embodied in this HP/Apollo Series 700 Model 735 workstation. The PA-RISC CPU handles geometry calculations, while the graphics subsystem performs rasterization.*

to calculate the slopes of the polygon's edges. Following this comes edge intersection and span setup. Here, the system determines the intersection of the polygon's edges with physical pixel rows from the vertex and edge slope data. Also calculated in this step is the length of the horizontal pixel rows that span (or fill) the polygon.

The final stage is *pixel generation*. Here, the graphics subsystem uses the Z-buffer data to determine the colors of the individual pixels that make up the display. Using shading calculations, it also determines how color will vary across the horizontal spans of the polygon.

The amount of data that must be manipulated increases dramatically at each step in the graphics pipeline. For example, because several spans per pair of polygon edges typically need to be calculated, the number of calculations involved in edge intersection and span setup is greater than that for the total process up to that point, including geometry calculation and edge setup. Similarly, there are typically several pixels per span, so the computational requirements of pixel generation are even greater. Because of this, the most cost-effective way to apply dedicated compute-power in a graphics-subsystem design is in the back end, where the complex rasterization process occurs.

You get the highest graphics performance when you implement the entire pipeline in hardware.

Depending on your cost and performance goals, a range of possible pipeline implementations exists, from doing it all in software to doing it all in hardware. The lowest-cost and lowest-performing option is the software-only pipeline.

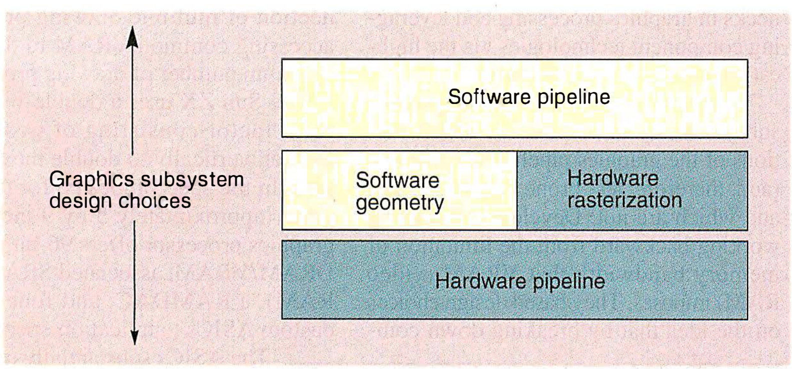
If the pipeline is implemented in software, then the CPU performs the graphics calculations along with the normal calculations involved in running your application. In addition to requiring many compute cycles, the amount of data that needs to be sent between the CPU and the graphics subsystem is very large. This implementation is typically acceptable only on fast CPUs with high I/O bandwidths or with small data sets.

Oftentimes, the architecture of the CPU can make a software-only pipeline an acceptable alternative. For example, Hewlett-Packard includes instructions in the PA-RISC architecture to facilitate the rapid movement of blocks of data from main memory to the frame buffer, resulting in acceptable 3-D modeling performance for many users even on nonaccelerated products such as the HP/Apollo Series 700 Models 715 or 735 with 8-bit plane color graphics all-hardware pipeline.

You get the highest graphics performance when you implement the entire pipeline, from geometry calculation to rasterization, in hardware. All-hardware implementations completely off-load the CPU and use custom, dedicated, high-performance processors to perform all computations in the graphics pipeline. Most graphics subsystems on the market today use this technique, including the DEC PGXT Turbo, the IBM Gt4x, the Silicon Graphics Elan and Extreme systems, and the Sun Microsystems GT.

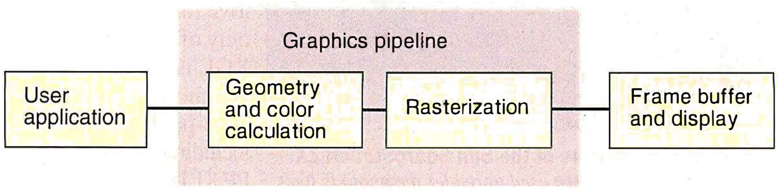
Although it provides the best performance, this implementation has several drawbacks: It is

Graphics Designs



You have three choices *in designing a graphics subsystem: perform both halves of the pipeline in hardware or software or perform geometry in software and rasterization in hardware. Hewlett-Packard believes the combination of software and hardware is the most cost-effective.*

Graphics Generation



As you move from left to right *in the graphics pipeline, the operations become more and more compute-intensive. Geometry and color calculation is normally considered the "front end" of the pipeline, while rasterization is the "back end."*

the most expensive option—typically out of the price range of average users. In fact, it is not uncommon for a graphics subsystem using this approach to cost more than the CPU it connects to. Moreover, performance is forever stuck at the level that the dedicated hardware pipeline provides, and it doesn't scale up with advancing CPU performance.

Solomon's Choice

Between the all-software and all-hardware solutions lies the combination of software and hardware. As was mentioned earlier, the computational demands of 3-D graphics increases toward the back end of the pipeline, where rasterization occurs. A graphics subsystem that includes hardware acceleration for the rasterization process significantly reduces the demand on the CPU, as well as the amount of data that must be sent from the CPU to the graphics board. HP uses a hardware/software implementation in its CRX-24Z and CRX-48Z graphics subsystems, available on the HP/Apollo Series 700 Models 715 and 735. The CRX-24Z uses a single-path rasterization engine based on custom VLSI running at 40 MHz. The CRX-48Z provides a dual-path approach running at a faster 62.5-MHz rate, delivering up to eight times the graphics performance of the CRX-24Z in some benchmarks.

Because rasterization is a well-defined and repetitive calculation, it can be implemented with reasonably low-cost hardware. Manufacturers can deliver high-performance graphics subsystems at a low cost by matching the amount of rasterization acceleration to the geometry-handling capabilities of the CPU.

A secondary benefit results from havingthe CPU process the geometry calculations: Graphics performance scales with increasing CPU performance. This is a valuable side effect in the current environment of exponentially increasing CPU performance.

In summary, the high performance of RISC CPUs has enabled HP designers to combine them with a rasterization engine to get high performance at a reasonable price. And HP's implementation of the pipeline assures that graphics performance will continue to grow as CPU performance grows. ■

Norton Ewart is a product manager for graphics workstations at Hewlett-Packard, and Larry Thayer is an engineer/scientist there. You can reach them on BIX c/o "editors."

Sun Breaks the Bottlenecks

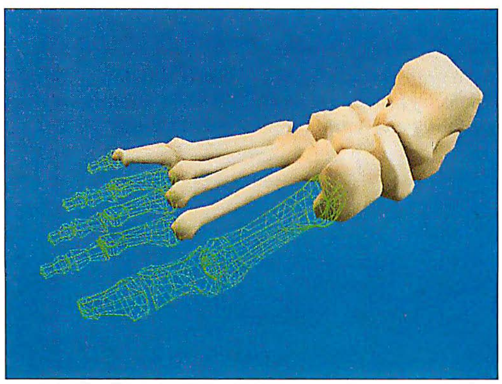
Sun Microsystems uses an all-hardware graphics engine that combines performance with economy

BILL FLEMING

The new Sun Microsystems SparcStation ZX 3-D graphics subsystem is designed to provide advanced graphics rendering for 3-D applications while reducing component and manufacturing costs. These days, few secrets are left when it comes to high-end graphics performance: Bringing affordable 3-D computing to a volume market lies in overcoming bottlenecks in graphics processing and leveraging component technologies via the highest possible level of integration.

The key to building the Sun ZX graphics subsystem lay in pinpointing which portions of the graphics pipeline are scalable (and, therefore, less prone to bottlenecks), and which are not. Developers began by working backward from the limitation of memory bandwidth that VRAM (video RAM) imposes. They based design choices on the idea that by breaking down complex geometry at the beginning state of graphics rendering, you could more effectively define and control the processing burden imposed on the individual FPUs. They got greater performance by providing scalable processing to rendering operations such as edge walking and span interpolation. Finally, they used the timing constraints associated with the cross-connection of multiple drawing processors accessing common VRAM to define the optimum number of drawing processors.

The Sun ZX uses a double-wide SBus form factor consisting of two boards, stacked vertically to double the available area. In the space allocated for two SBus cards (approximately 5 by 9 inches), the graphics processor offers 96-bit planes of DRAM/VRAM, associated SRAM (static RAM), a RAMDAC, and four types of custom ASICs (application-specific ICs). The ASICs substantially reduce the requirement for discrete chips and eliminate glue logic. Higher integration also provides additional size and power reduction.



An important feature of the Sun SparcStation ZX graphics architecture *used to render the photo is its ability to perform dynamic tessellation of NURBS (nonuniform rational B-splines) curves and surfaces. NURBS are concise, yet powerful, representations of simple and complex geometries. From a high-level mathematical description, the graphics system tessellates curved geometry into lines (in the case of curves) or triangles (in the case of surfaces).*

The Sun ZX is optimized to accelerate the geometry-oriented XGL foundation graphics library, which includes 2-D and 3-D graphics primitive functions to support a wide variety of graphics-based applications. XGL is the foundation interface on which most industry-standard and third-party graphics APIs are built, including OpenGL, PHIGS, HOOPS, PEXLIB, and others.

Inside the ZX

The main elements of the Sun ZXare the command ASIC, four floating-point processors, five drawing processors, and the frame buffer that

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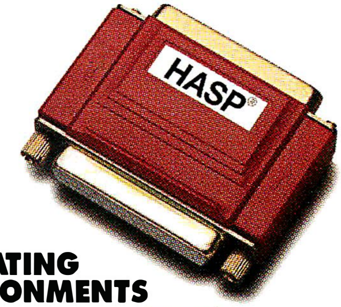
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holds the image bit map. Together, these form the graphics pipeline of the Sun ZX.

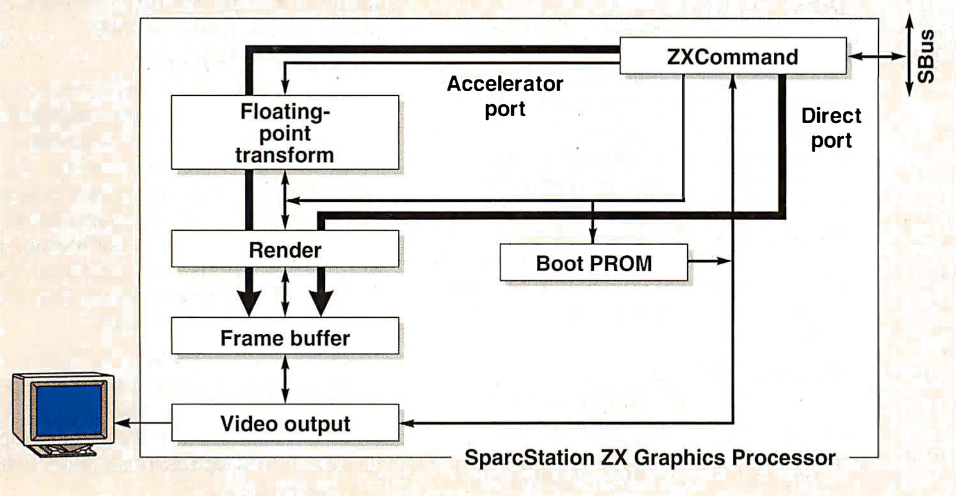
First in the chain is the ZXCommand ASIC, which converts application-generated chained vertex data into a number of isolated drawing primitives. The incoming vertex data, which exists in a variety of numeric formats, contains position data, vertex and facet, normal and color information, edge highlight flags, and chaining information. Normal and color information are represented as 32-bit floating-point numbers. The command processor converts this data into isolated triangle and line commands—all with floating-point arguments—before sending it to the floating-point ASICs.

The next section of the pipeline is the floating-point transform. It consists of four custom ZXFloat ASICs, each with its own SRAM. Each ZXFloat is a specialized floating-point processor that is optimized for low-level graphics operations that scale linearly in performance. The SRAM contains microcode used by the ZXFloat chip to perform its specialized operations.

The ZXCommand ASIC accesses each ZXFloat chip to determine if the chip is busy or available. If a ZXFloat is available, the ZXCommand chip sends it a graphics primitive via its accelerator port. The ZXFloat processes the primitive and signals the ZXCommand chip when it has completed processing. The ZXCommand chip then arranges for the result to be sent from the ZXFloat chip to the render section of the pipeline.

The ZXFloat chip converts individual dot, vector, and triangle data from 3-D model coordinates to 3-D world coordinates and then to 3-D device coordinates represented by frame-buffer pixel locations and Z-buffer values. It performs lighting calculations that result in three floating-point values (i.e., RGB) for each vertex. These values are a function of the color and surface properties of the triangle, the color of the lights, and the angle that the light hits the surface. In addition, ZXFloat performs window clipping on the rendered image.

Diagram of the Graphics Subsystem of the SparcStation ZX



Sun Microsystems implements the SparcStation ZX pipeline *using ASICs, which cut down on the chip count and add flexibility to the design. One ASIC acts as the command processor, while the four that make up the floating-point transform perform geometry calculations and the five in the rendering section write to the bit map. A final ASIC handles output to the monitor.*

Rendering an Image

The render section of the Sun ZX graphics pipeline consists of five ZXDraw ASICs. Each controls one-fifth of the frame-buffer memory, which is organized into a five-by-one interleave factor. Each ZXDraw processor operates independently; together they can render up to the maximum VRAM bandwidth.

The ZXDraw ASIC has two internal data paths for rendering: accelerated and direct. The accelerated geometry path contains drawing hardware for 3-D images, while the direct path allows access to the frame buffer for windowing systems and applications that do not need to pass through the transformation pipeline.

For 3-D accelerated operations, ZXDraw converts the dot, vector, or triangle parameters calculated by the ZXFloats into pixel operations for the frame buffer. For the vertices, ZXDraw receives various values, such as the slopes of the sides of a triangle, and the corresponding increments for the RGB values. ZXDraw fills in all the intermediate pixels that the vertices outline. ZXDraw is also responsible for raster operations, vector antialiasing, alpha transparency, and Z-buffer algorithms.

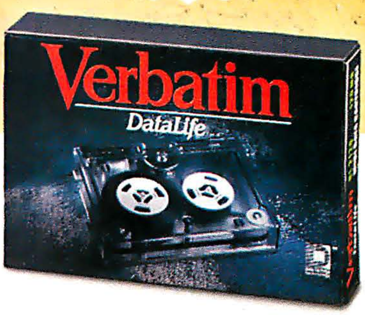
The ZXDraw processors operate on the bit map held in the the Sun ZX frame buffer, which consists of 1280 by 1024 pixels by 96-bit planes. The memory planes are organized as 48-bit image planes, a 24-bit plane Z-buffer, eight overlay planes, 10 window ID planes, and six fast-clear planes.

The 48-bit image planes hold a color value for each pixel to be displayed. The system uses one of two color models: 24-bit RGB true color or 8-bit indexed color. The color model is selected on a per-pixel basis by the window ID planes. In the 24-bit true-color model, two separate 24-bit planes are dedicated to displaying the 16.7-million-color gamut. Each 24-bit plane is divided evenly into 8-bit planes each for the three primary colors: red, green, and blue. The two frame buffers are referred to as buffer A and buffer B. As the system displays the image in buffer A, the next stage in the image's transition is being drawn in buffer B. When the contents of buffer B are complete, the display is switched from buffer A to buffer B.

The 24-bit Z-buffer stores the depth value for the last pixel written at a given location into the image buffer. Z-buffering enables the system to make visible the portions of an object that are nearer to the viewer and hide the portions that other portions of the object should conceal. This process is called *hidden surface removal*, and a ZXDraw ASIC performs it. The process tests to determine which faces are in front and removes those surfaces that should be hidden.

continued


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The eight overlay planes on the Sun ZX serve as an additional 8-bit indexed color frame buffer. The overlay data can be transparent or solid. Overlay planes provide nondestructive annotation of underlying 8- or 24-bit images. They enable an image (e.g., a mail tool) to be temporarily superimposed over another image without affecting the image underneath; it need not be redrawn when the overlay image is removed.

The six fast-clear planes implement the fast-clear function for three selected double-buffered image windows or for six single-buffered windows. Each fast-clear plane pair can be assigned to clear one double-buffered window at optimized hardware speed. Before the beginning of a new frame, the appropriate fast-clear plane is cleared to all zeros, using a special high-speed clear mode, indicating that the values stored in the image and Z-buffer planes are invalid for a specified window.

Video Output

The last stage of the graphics pipeline is the video-output section, which consists of the ZXCross ASIC and a RAMDAC. The ZXCross ASIC contains the window ID lookup tables and the color lookup tables, along with the programmable video-timing generation and hardware-cursor generation logic. The window ID lookup tables define the window's display properties, such as the color mode, double-buffering, and so on. The color lookup tables are, in essence, color maps, which contain a selection of colors for a particular application. Color lookup tables are used primarily in 8-bit indexed mode.

The ZXCross ASIC performs output pixel multiplexing (buffer and channel selection, pseudocolor lookup, and gamma correction, as required). The system supports many monitor resolutions, ranging from NTSC at 640 by 480 pixels to 1280 by 1024 pixels noninterlaced. The ZX system can also output stereo images that require the use of stereo glasses.

Sun Microsystems believes that the SparcStation ZX graphics subsystem will usher in an era of affordable high-performance 3-D graphics. Perhaps then, high-end graphics systems can finally achieve high volumes, helping users solve many computing problems. ■

Bill Fleming is a senior product manager at Sun Microsystems (Mountain View, CA). You can reach him on BIX c/o "editors."

DAMN THE TORPEDOES!

Silicon Graphics takes an immediate approach to imaging with its full-speed-ahead RealityEngine[2]

DOUGLAS VOORHIES

Silicon Graphics, Inc. is focused on graphics technology. All its workstations, from $5000 personal machines to million-dollar multiprocessing supercomputers, can display dynamic 3-D color images. While the emphasis at the low end is on price and performance, the emphasis at the high end is on raw performance and superior image quality.

Achieving smooth motion (30 to 60 frames per second) while using sophisticated rendering techniques is far more demanding than the more modest rates common in the marketplace. It requires powerful hardware acceleration; in some high-end configurations, the graphics hardware exceeds the cost and complexity of the rest of the system. And it requires that the system and interface be designed from the start to accommodate such accelerators.

Graphics for a Dynamic World

SGI emphasizes its *immediate-mode* approach to the graphics hardware/software interface. To minimize system bandwidth, most systems send a description of the surfaces to be rendered to the graphics subsystem, which redraws them frame by frame as the viewpoint changes. This technique is called *retained-mode* graphics. On the other hand, with immediate mode, the surface description is sent repeatedly, every frame, without retaining the previous surface description in the graphics subsystem. This has the obvious cost of repeatedly sending data that may change infrequently; however, it has two profound and subtle advantages.

First, immediate mode allows applications that display changing information to run as efficiently as those with mostly static information. Immediate mode invites rather than punishes dynamic applications. Second, retained information in a graphics subsystem is essentially a "second database" that duplicates data structures inside the application. When that data changes, the retained data must be edited synchronously. It's a bit like keeping a document in a laser printer and sending editing commands to the printer rather than simply sending the final version in its entirety. Because immediate mode doesn't need to synchronize an application's data structures with data stored in the graphics subsystem, it is far easier to program. Of course, for those of you with static scenes, SGI's OpenGL—a programming interface and library for 3-D graphics applications—supports retained graphics as well.

SGI also goes far beyond displaying static scenes by enriching its workstations with digital media. Adding 3-D graphics to a multimedia presentation can create a crisp and dazzling impression, and video I/O lets you use live images to decorate 3-D surfaces or use them as backgrounds to 3-D scenes. In addition, you can harness the power of the rendering hardware to perform real-time image manipulation on a video stream.

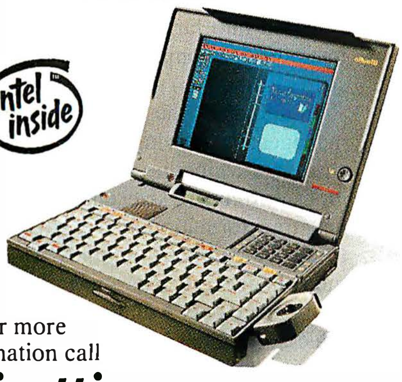
Silicon Reality

The system that best exemplifies immediate-mode graphics is the RealityEngine[2]. It differs fundamentally from other graphics devices because its primary rendering method combines antialiasing and texture mapping. The result is on-screen images that look uncannily real, with rich surfaces and without jagged edges.

Antialiasing is the process of eliminating the interference between high-frequency edges in the image and the grid of pixels

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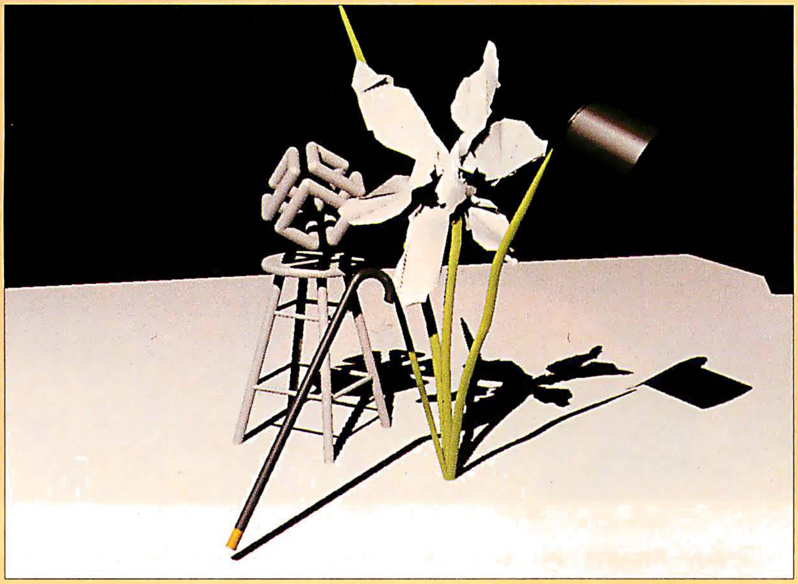
that compose the screen. Just as CDs sample sound at a high 44-kHz rate, antialiased rendering samples the colors and shades at several places inside each pixel to ensure that the fine details and abrupt edges are represented as faithfully as the pixel grid allows. The effects of antialiasing are most evident in the elimination of jagged edges.

Texture mapping adds a level of indirection to 3-D graphics, analogous to pointers and subscripts in conventional programming. Instead of varying colors smoothly across a surface, which produces a chalky appearance, the graphics system paints an image stored in an alternative memory array on the surface. This image can give the surface the appearance of brick, gravel, or fabric, as well as the reflection of gloss or metal. The surface seems real because the texture is often created photographically. Texture mapping warps the texture photograph onto the surface, squeezing it if the surface is viewed obliquely or shrinking it if the surface is far away. The result is a major improvement in visual realism, although the math required, which is based on projective geometry, is arduous and compute-intensive.

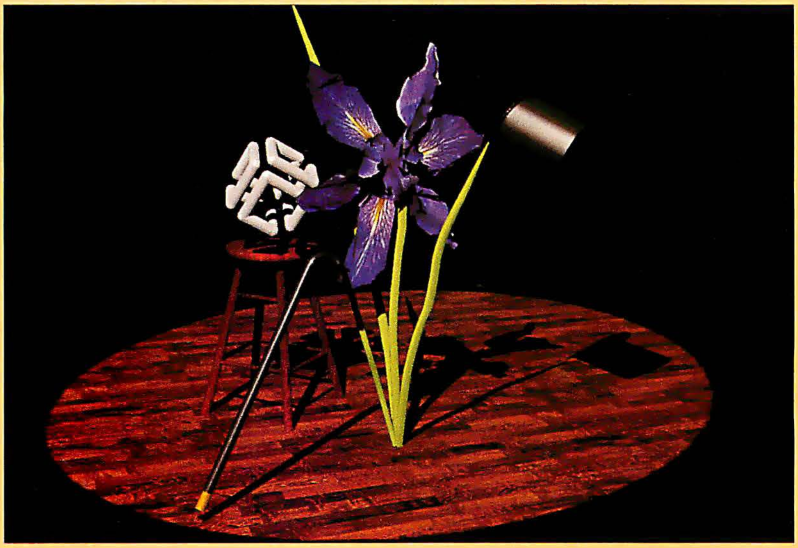
Many other workstations, including earlier models from SGI, can do texture mapping or antialiasing, but always with a dramatic speed penalty. The RealityEngine² invests enough hardware and microcode to do both at full speed.

Effects of Texture Mapping

Without



With



Surfaces without texture *(top) appear dull and chalky. Although the illumination and occlusion of hidden parts gives a clear 3-D effect, the surfaces appear artificial. Mapping a photographic texture onto the surfaces makes the scene come to life (bottom). The floor looks like wood, and the flowers seem real. Shadows tie each object to its position above the floor.*

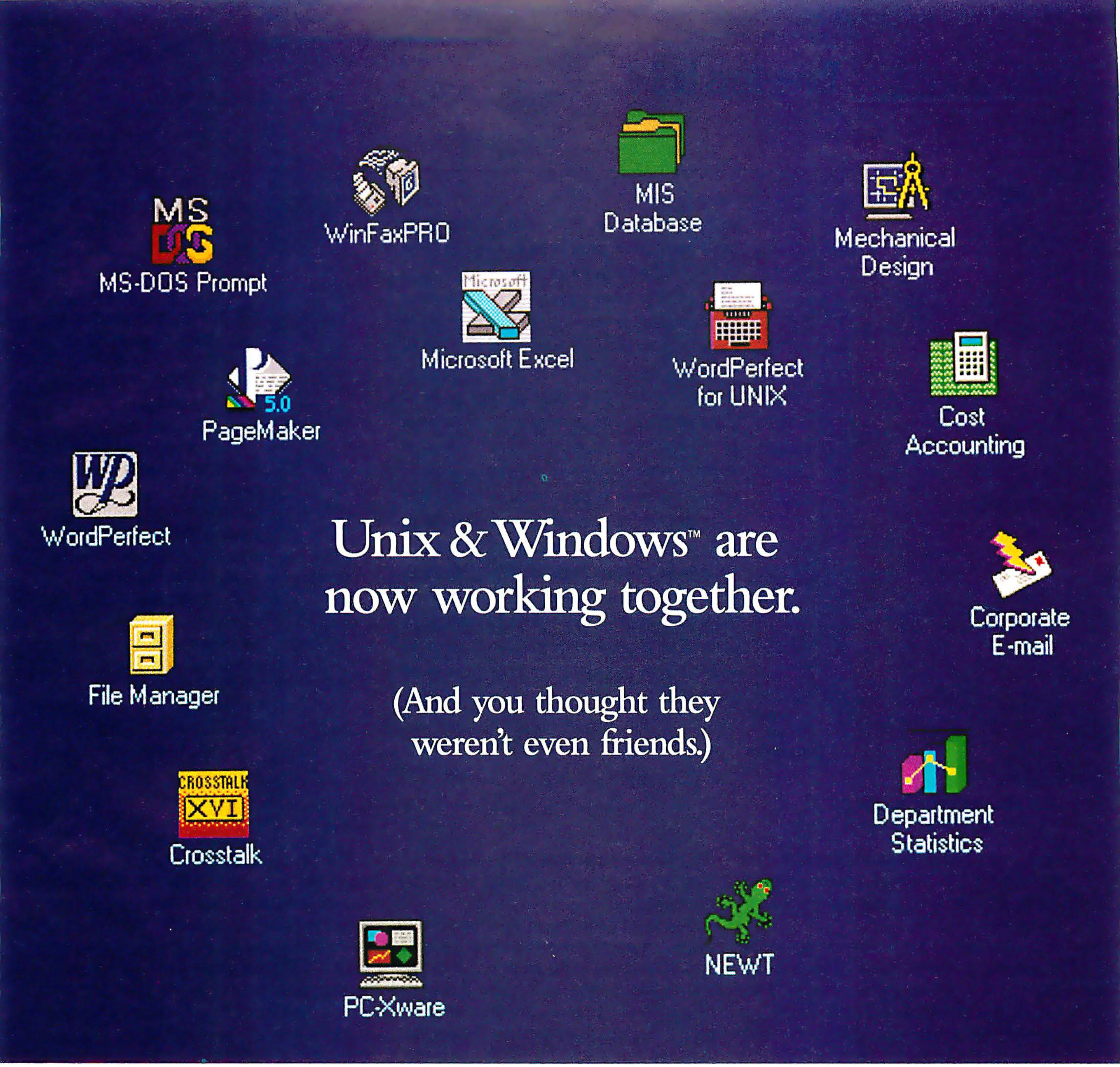
The Design of Reality

Architecturally, the RealityEngine² is fashioned as a short pipeline, with most of the stages being richly parallel. Over a succession of generations, the pipelines in SGI 3-D renderers have gotten shorter and shorter, with the important stages getting wider and wider. Pipelines run at the speed of their slowest stage, whereas independent parallel processors are not so limited.

The first stage of the RealityEngine²'s pipeline starts with the command processor, a complex-state machine that parses the incoming drawing primitives, rearranging them as necessary, and divides them up into 12 parallel streams for the next stage. Small commands may be assembled into larger commands, and extremely large commands (e.g., draw a long strip of triangles) may be broken up.

In addition, the command processor manages the drawing state for the second stage in the pipeline, the 12 geometry engines. Infrequent state changes, such as a new transformation matrix, are broadcast to the 12 geometry engines. More common changes, such as a new vertex color, are bundled only with the commands they affect. The result is a reduction in the data flowing to each geometry engine, with each engine being given reasonable units of work.

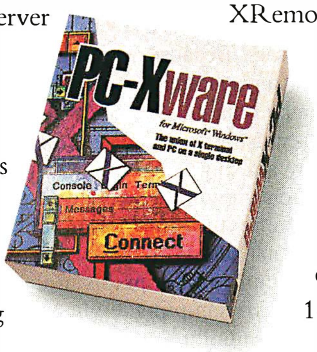
The 12 geometry engines work independently and in parallel on the data generated by the command processor, performing floating-point math to prepare each primitive polygon for rasterization. Each engine consists of an Intel 860XP RISC processor, a formatting and control



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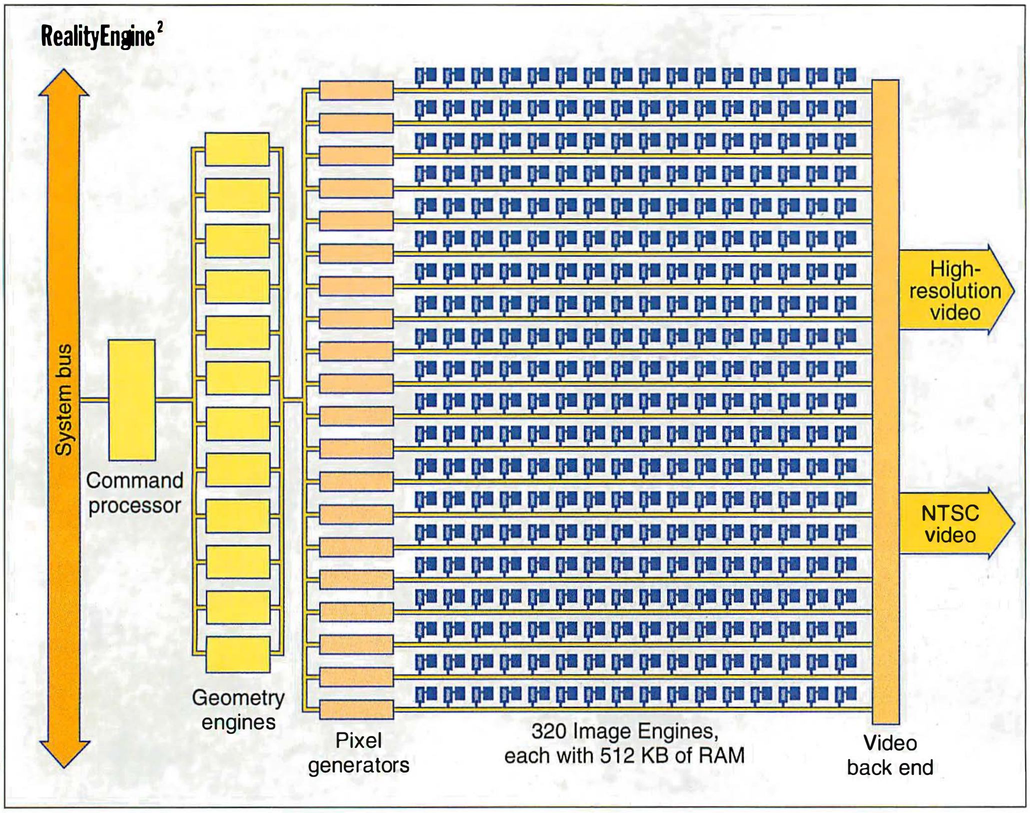


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With the processing bandwidth *of a supercomputer, the RealityEngine² uses parallelism to achieve real-time texture mapping and antialiasing of 3-D images.*

chip, and 2 MB of memory. Together they provide 1.2 GFLOPS of processing bandwidth, the raw calculation power of a supercomputer.

This power is necessary to handle the projective-geometry calculations to transform each graphics primitive (e.g., a triangle or a quadrilateral) onto its screen position and to determine what color each vertex should be, based on the primitive's material, position, and orientation relative to light sources. The geometry engines also set up the iterative calculations performed by the final stage in the pipeline. The engines work in parallel, taking tasks from the command processor in round-robin order. Because bit-map pixels can be looped back through the command processor, the power of the geometry engines can also be used for image processing. For example, a five-by-five convolution of a 1024- by 1024-pixel image takes less than 66 milliseconds.

Creating the Bit Map

The final stage in the pipeline consists of 20 pixel generators, which compute the color and other parameters for each pixel. Each pixel generator has a copy of the 16-MB texture memory (320 MB total). This 20-way replication allows the RealityEngine² to generate 1 pixel every 2.5 nanoseconds.

The pixel generators step from pixel to pixel, interpolating the color, screen X/Y/Z, distance to the surface, 2-D or 3-D texture address, and other parameters. They also read the texture memory and compute a fog density based on the surface distance. For pixels that the drawn primitive only partly covers, the pixel generators create a mask describing that coverage and adjust the color to reflect the centroid of the overlap.

Texture access is a key role for the pixel generators. Because warping the texture onto a surface involves zooming it up or down by noninteger amounts, the texture pixels must be sampled carefully to avoid texture aliasing.

When viewing a surface in perspective, the texture-index computation involves an onerous division at every screen pixel. Four texture pixels are averaged for *bilinear* sampling, eight are used for *trilinear* sampling, and 16 are needed for *bicubic* sampling. This image warping and resampling power can be harnessed for 2-D image processing, allowing full-screen image zooms and rotates and warps at 60 Hz. Achieving texture access at the 2.5-ns-per-pixel rate was probably the single greatest technical challenge in the RealityEngine².

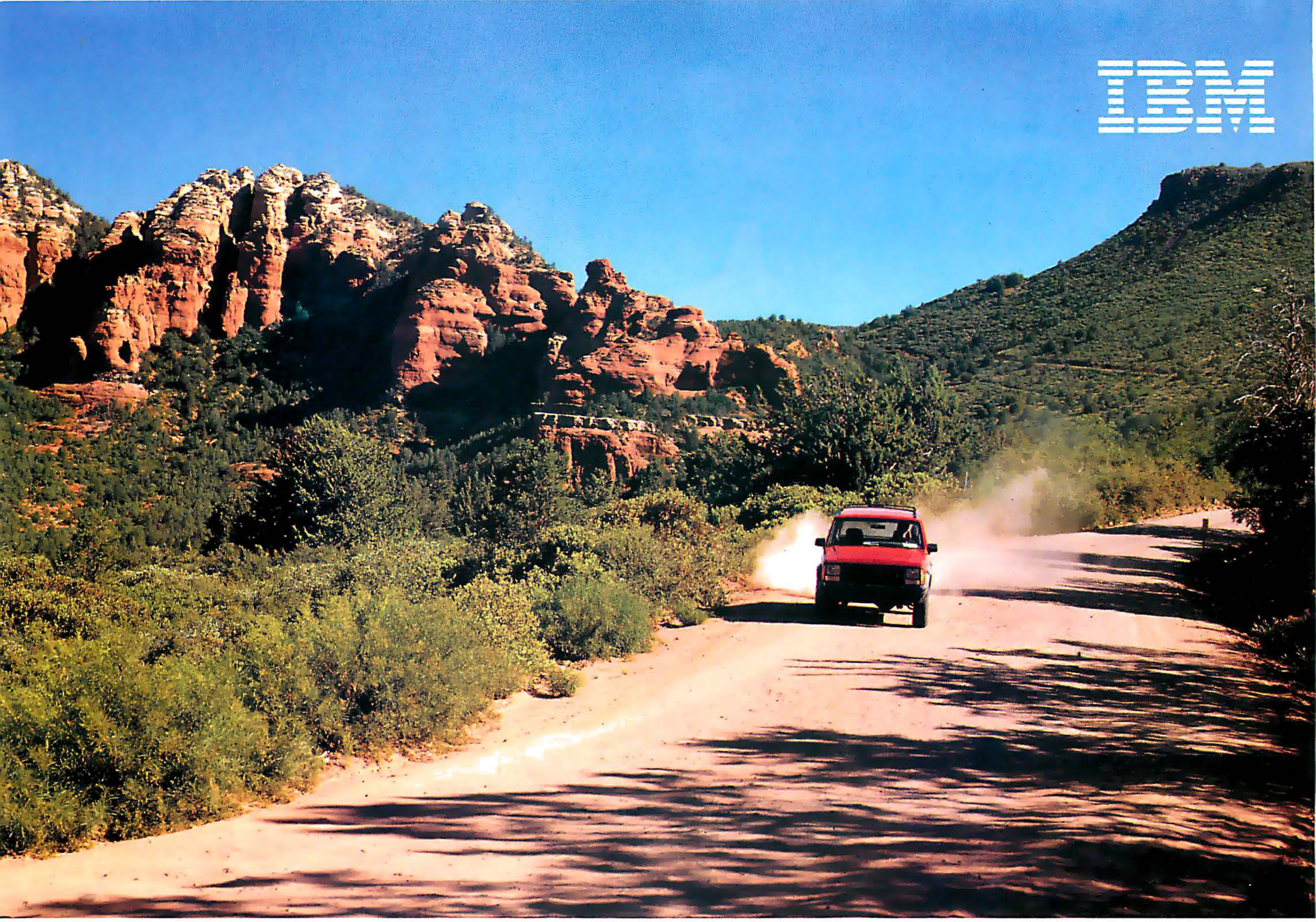
Once the pixels are generated, the Image Engines write them into the bit map. For each relevant subsample of each pixel, the Image Engines determine which surface is in front of the others. The Image Engines then combine the subsamples to produce the pixel color. Storing all the image information—including multiple buffers with 12 bits each of RGB and alpha (i.e., transparency) values, as well as the screen Z coordinates for every subsample—requires up to 1024 bits per pixel. To achieve the 2.5-ns-per-pixel bandwidth, the Image Engines are a parallel array of 320 image processors, each controlling 512 KB of bit-map memory.

The Image Engines also read the pixels in blocks and send them to the video circuitry. After a table lookup, the pixels form the video signal sent to the monitor. At 160 MB, the bit map is large enough and has sufficient access bandwidth to support multiple independent monitors or even HDTV. An extra roving NTSC channel makes it easy to videotape an application running in a window.

The focus on graphics that gives rise to such extreme architectures accounts for SGI's success in applications where graphics performance and visual image quality are paramount. As the performance of computers skyrockets, interacting with them in new ways becomes not only possible but essential. From CAD to molecular modeling to visual simulation and movie production, 3-D graphics is getting less and less arcane and more and more mainstream.

The visceral experience of immersing yourself in a rich visual application is something new. Once you experience it, you never want to go back. ■

Douglas Voorhies works in corporate R&D at Silicon Graphics, Inc. You can reach him on BIX c/o "editors" or on the Internet at voorhies@sgi.com.



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Drive(s)	3.5"	3.5"	3.5"	3.5"
Monitor	IBM 14V 14" SVGA NI	IBM 14V 14" SVGA NI	IBM 14V 14" SVGA NI	IBM 14V 14" SVGA NI
Operating System	IBM DOS & WINDOWS™	IBM DOS & WINDOWS	IBM DOS & WINDOWS	IBM DOS & WINDOWS
Price*/ IBM Credit Lease**	**$1,539** / $56 per month	**$1,649** / $60 per month	**$1,709** / $62 per month	**$2,489** / $90 per month
Features	**425SX/Si**	**433SX/S**	**433DX/D**	**466DX2/T**
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Hard Drive/Memory	212MB/4MB	120MB/4MB	120MB/4MB	527MB/4MB
Drive(s)	3.5"	3.5"	3.5"	3.5"
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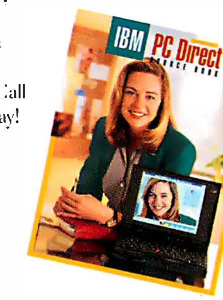
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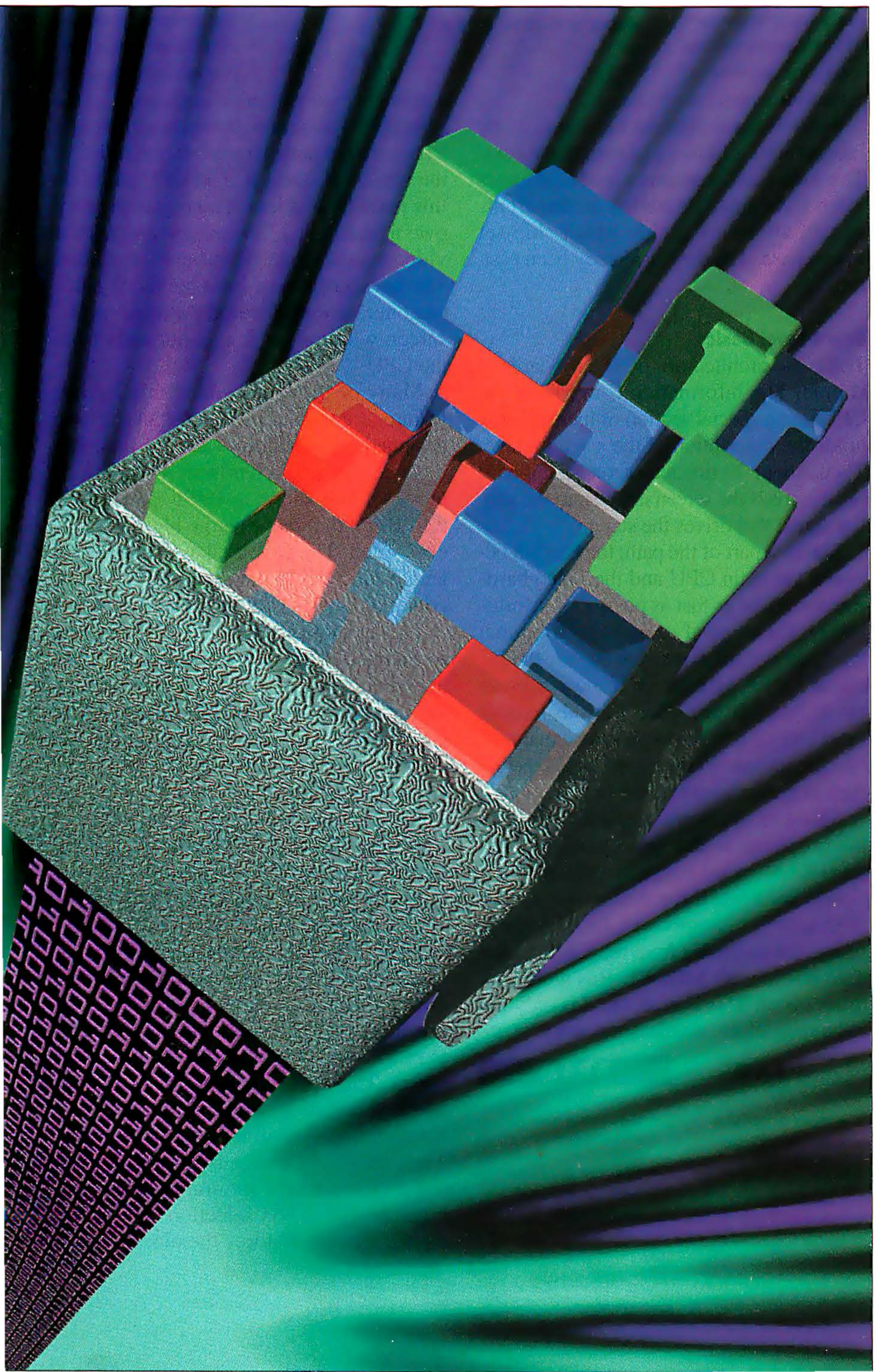
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State of the Art

INSIDE WINDOWS ACCELERATORS

GUI accelerators increase system performance by relieving the CPU of some basic graphics manipulation tasks. Here's how they do it.

PETER WAYNER



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When PCs ran DOS only, they provided adequate video performance using video cards tuned for either graphics or text output. Today, Microsoft Windows is placing great strains on PC hardware because it forces a machine to employ graphics for all output—text as well as icons and windows. This load can bog down even the fastest 486.

Fortunately, a class of video adapters has emerged that can directly handle many of the screen manipulation chores that the CPU formerly performed. These GUI accelerators are essential if you want a fast graphical interface.

The additional demands of a graphical interface like Microsoft Windows are daunting. Every time you open a window, the system must draw its contents on the screen. The same thing happens when you pull down a menu. Whenever you open a window with a resolution of 200 by 200 pixels, your system must manipulate over 40,000 pixels. If you move the window, your system must change up to 80,000 pixels to reflect the new position.

The old text-style displays (CGA), on the other hand, consisted of a 25-row by 80-column matrix. The video hardware converted ASCII characters directly into pixels. Drawing an *A* was as simple as writing a 65 (the ASCII code for *A*) into the right memory location. Changing an entire screen or drawing a window required no more than 2000 operations where the CPU wrote a value to memory.

Using the older-style display technology, your Windows machine would have to be at least 40 times faster than your text-based DOS machine to generate the same apparent level of performance. This estimate is conservative, too, because I am only comparing the act of moving a 200- by 200-pixel window in a Windows environment to completely redrawing the screen from an old CGA card. This means, of course, that you can't use the older-style

display technology if you want decent Windows performance.

To compensate, Windows accelerator boards are designed to make communication between the CPU and the video hardware and between the video hardware and the monitor as fast as possible. A graphics accelerator chip set provides additional intelligence to bundle a long sequence of similar operations into one powerful screen-drawing command.

Most of the design excitement is in the laboratories of the chip manufacturers. The board and computer manufacturers often have little flexibility in the architecture after they decide which chip set to purchase. The die has already been cast, literally.

Board-Level Basics

The basic architecture of video boards is simple. The information flows from the CPU into a special section of memory that holds the description of the screen image. Then, about 70 times a second, the board must convert the screen image into the analog signal that drives the screen.

The first part of the path, the conduit between the main CPU and the video hardware, must be as fast as possible. Unfortunately, the original design specified that the main system expansion bus for the PC run at only 8 MHz, even if the processor ran at 50 MHz or higher. For this reason, most serious designs bypass the expansion bus and include a high-speed local bus that runs at the same rate as the processor.

Speeding up the information flow from the processor to the video hardware and local RAM-based image of the screen is a simple solution. If the data moves faster, then screen changes will be that much faster. But switching from the 8-MHz standard bus to a 50-MHz VL-Bus works six times faster. This is nice, but it is only the beginning of the acceleration story.

VRAM	DRAM
• more expensive • two read/write ports • no conflicts between drawing and refresh	• less expensive • one read/write port • possible conflicts between drawing and refresh

GUI ACCELERATOR FUNCTIONS

- FRAME BUFFER
- BITBLT
- HARDWARE CURSOR
- LINE DRAWING
- CIRCLE DRAWING
- POLYGON FILL

Adding Intelligence

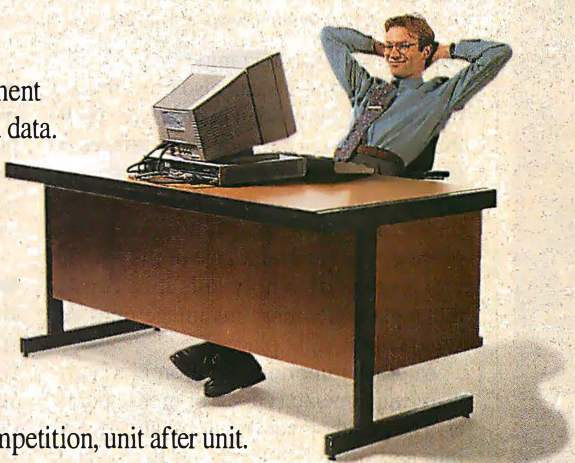
The most common solution to speeding up GUI functions is to pack additional intelligence into the video hardware. Standard graphics adapters simply maintain the image of the screen in RAM (i.e., the frame buffer) and depend on the CPU to update each pixel. This is not very efficient because a number of Windows commands consist of telling the video hardware to perform a repetitive operation on large areas of the screen. It is common, for instance, to paint a background pattern over a large portion of the screen at start-up. The CPU could do this pixel by pixel, or it could simply ship over a small clip of the pattern and ask the video hardware to repeat it everywhere. The latest chips now have the intelligence to generate complicated patterns on the screen with only a few commands from the CPU.

Many of these embedded intelligence features are standard on almost all chip sets designed to do Windows acceleration. The most common is a hardware-based block move solution known as BitBlt (pronounced "Bit Blit") that moves large blocks of pixels around. The BitBlt takes a source rectangle and a destination rectangle and then copies all the bits from one to the other.

This approach speeds up graphics performance for two reasons. First, the connection between the video controller chip doing the copying and the RAM holding the screen is much faster than even the local bus. The Tseng Lab W32i chip, for example, can maintain this connection at 162 Mbps. Second, the width of the path between this RAM and the controller can be many bits wide, allowing all this data to transfer at once. The Western Digital WD-35, for instance, has a 64-bit-wide path.

The BitBlt operation is used in two important ways. First, when you move a window, the system copies the old image from one location to another. You do not have to redraw the window contents object by object. This approach is even more useful when you pull down a menu or open a small dialog box on top of other images. Then a covered image is copied into unused video-board memory. When the menu or dialog box selection is completed, the system restores the old image by

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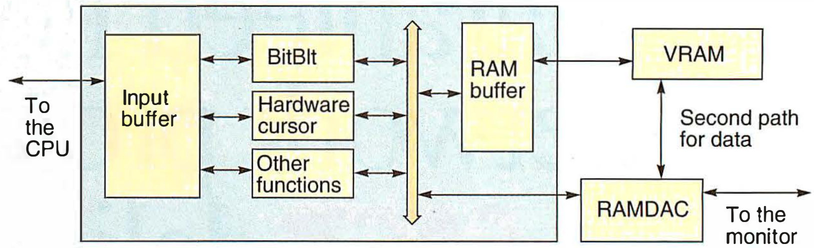
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VRAM-Based GUI Accelerator Board



The second port on the VRAM *allows the data to flow to the display device at the same time that new drawing information arrives from the GUI acceleration hardware.*

copying back this rectangle.

BitBlt operations can also draw text on the screen. Many video boards have built-in font caching, and they store images of the individual characters in unused memory on the video board. When it comes time to draw an *e*, there is no need for the processor to send an image of the *e* to the video board. It simply tells it to copy a rectangle containing this image onto the screen in the right place.

Another important solution is a hardware-implemented cursor or mouse pointer. The pointer image is almost always visible and often in motion on the screen. Obviously, you could use BitBlt to implement the movement of the mouse pointer, but this is not very efficient. Most video chip sets maintain the pointer image as a small bit mask (32 by 32 bits or 64 by 64 bits) that is kept in unused memory. They also keep track of the *x*,*y* coordinates of the pointer. When the system constructs the screen image, it automatically draws the pointer in the place designated by the coordinates. This is much faster, because the system can move the mouse by simply changing the coordinates. There is no need to copy the cursor on and off.

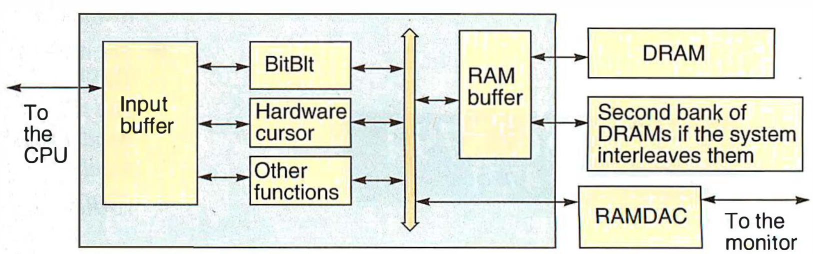
Many extra features make performance better but are not as generally useful or used as BitBlt and hardware-pointer support. These extra features have commands that let the graphics subsystem fill a polygon with a color or pattern and perform hardware-assisted line and circle drawing.

Memory Matters

Building a fast, intelligent video controller speeds up the system by reducing the traffic over the bus. This approach has been so successful that the bus is rarely the bottleneck for most applications. Today, the most important bottleneck in a PC graphics system is the bandwidth in and out of the memory on the video card.

The demands on video memory are high. If you are running Windows at a resolution of 1280 by 1024 pixels with 8 bits of color per pixel, then your machine must send 1.3 MB of data from the video memory to the screen 72 times each second. This 92 MBps of bandwidth is necessary simply to keep the screen running: Any additional drawing operations require extra bandwidth. This is why companies try to maximize the bandwidth between the video controller and the memory.

DRAM-Based GUI Accelerator Board



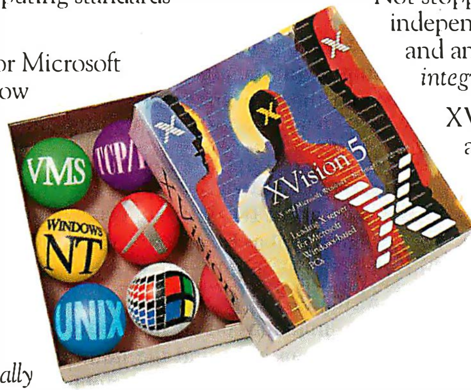
The screen image must flow *back through the accelerator hardware before it is sent to memory, causing conflicts with screen-drawing information.*

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One major problem is that VRAM chips are more expensive—often 1.7 to 2 times more—than comparable DRAMs. For that reason, cost-conscious designers have found that by changing the way the system accesses the chips, they get almost the same performance out of DRAMs that they get out of VRAMs.

One solution that Tseng Labs took with its W32i was to divide the DRAMs into two different blocks (i.e., interleaving), putting the odd addresses in one half and the even in the other. Now the video-control chip could ask for two blocks of information at once, as long as one request was for an odd address and one was for an even address. This is almost always the case when large blocks of image are being copied. Tseng Labs claims to have measured bandwidth in excess of 160 MBps.

How is this better than a VRAM solution? The hottest VRAM solutions often have almost 90 MBps of bandwidth available through each of the ports. The problem is that the bandwidth is not flexible. A 90-MBps bandwidth must go toward updating the screen, and 90 MBps is available for new drawing and BitBlt commands. The 160 MBps of the Tseng Labs chip can be split as needed. If you're running Windows in a lower resolution (e.g., 1024 by The VRAM solution cou... this, because only 90 MBps can be dev... ed to screen refresh.

Video architects have also explored other solutions to double the width of the data path between the main controller chip and the memory. Western Digital and Cirrus Logic both use 64-bit-wide buses for their latest chips (the WD-35 and the Cirrus Alpine). This is easier in one sense than interleaving, because there is no need for complex timing algorithms to govern accessing the two different sections of memory. It is more expensive, though, because the chip package and the internal buses must be twice as big. These wide buses offer about 180 MBps of bandwidth.

Fattening the bus by doubling the size or interleaving is much easier to do with DRAM than with VRAM because of the practical limitations on the number of pins that a chip can have and the number of traces that can be drawn on a circuit board. VRAMs already have twice as many pins as DRAMs because they have two ports. More pins mean more circuit board traces and more complex manufacturing standards that raise the price. Weitek still chose to use interleaved VRAMs in its Power 9100 line and found it was able to maintain a phenomenal 200 MBps.

in/fi...

poses. First, it buffe... chip can accept further instructions from the main processor while it is working. If the video processor is in the middle of a BitBlit operation, the main processor can continue to off-load drawing instructions without waiting. The second effect is to allow larger instruction-word sizes. The Cirrus Logic CLGD5434, for instance, joins every pair of 32-bit blocks that arrives into one 64-bit instruction. Other processors do the same thing when they buffer the 16-bit input from the VL-Bus.

All chips also buffer the data between the video controller and the memory. The Chips & Technologies Wingine DGX offers a buffer that acts like a cache. When the screen is being refreshed, it can read the information from this buffer and not spend the additional time required to access the video memory.

The construction of the image for refreshing the screen is handled by both the main processor chip and the RAMDAC that converts the digital bits into an analog RGB signal accepted by monitors. When a screen is working in 8-bit mode, the screen can have only 256 total colors

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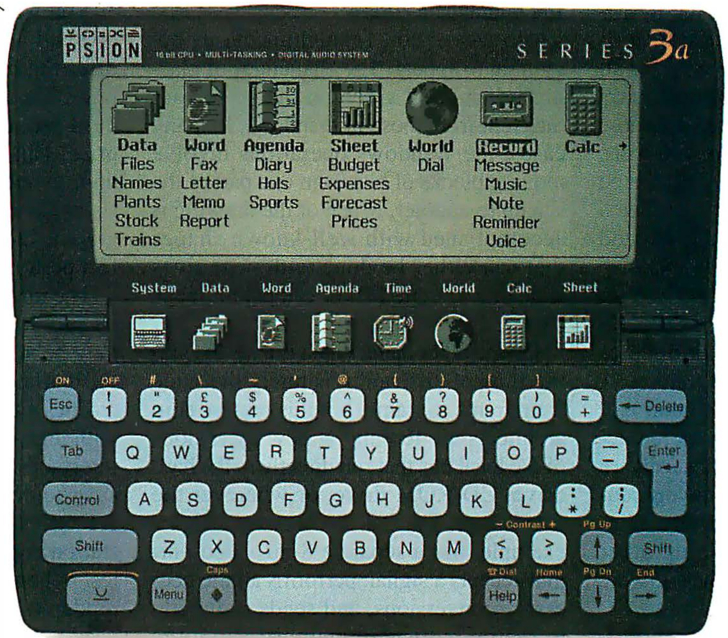
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available, because only 8 bits of information are stored for each pixel. The RAMDAC keeps a color lookup table that matches each of these 256 values to a 24-bit full RGB color definition. When an 8-bit image is being displayed, it will automatically replace the 8-bit values with the correct 24-bit RGB values.

Most companies implement the RAMDAC on a separate chip because there is not enough space on the main chip for all the functions. The Cirrus Logic and Sierra architecture teams, on the other hand, chose to squeeze it on the main chip to save costs. Although this decision may have hampered some functionality, it let them produce a good, low-cost solution. Extra chips add to total board costs, because they take up more board space, require extra circuit traces, and make assembly more difficult.

This trend will no doubt continue as price consciousness drives the market. A designer could use the extra silicon real estate for more functionality or more integration. The hardware cursor, hardware BitBlt, and some simple line-drawing routines make up most of the load on a Windows machine. Why keep adding other seldom-used functions when the software doesn't use them?

In the future, you may see general-purpose processors used more as graphics engines as the software begins to make increased demands on the graphics architecture. Some members of the Silicon Graphics Indigo line, for instance, use a Mips R4000 for its main processor and another R4000 for the graphics processor, because the chip offers very good floating-point arithmetic performance that is useful in rendering good 3-D effects. Many graphics accelerators will take this processor approach as the demand for good graphics increases.

The Multimedia Future

Video accelerators for multimedia are beginning to appear. The challenges of placing full-motion video on the screen are different from those of Windows. In many cases, the Windows operations involve moving blocks of bits from one part of the screen to another. Much of the drawing is accomplished with well-known shapes that can either be done with primitives (line or rectangle fill) or cached bit maps (fonts).

On the other hand, video is a never-ending flow of bits, and it is rarely the same from frame to frame. For this reason, chip architects are looking at new extensions of the local bus that run directly to the hard drive, CD-ROM drive, or wherever the data is kept. The Oak Technology 107, for example, has a separate 8-bit video port that accepts a signal, performs all the necessary conversions, and sends it directly to the main display memory. Now the video signal is part of the image.

The next generation of video chips will maintain several features that will take this stream of data and perform basic manipulations on it. The Western Digital WD-35, for instance, will offer a *stretch blit* operation that will stretch a small image to fit any rectangle on the screen. It will also clip the image on the fly to fit into a smaller rectangle. This makes it possible for the software creator to place moving images anywhere on the screen. These features are certain to become common in this generation of chips.

You will continue to see an expanding low end where manufacturers compete to offer the most features at a rock-bottom price. These chips will be popular because most people buy their PCs based solely on price. This part of the market should continue to be the most exciting, because analysis of Windows software shows that extra graphics features do not substantially affect performance that most users need.

The middle-range chip sets will expand by providing multimedia capabilities. It may be at least two or three years before the market grows through this period and reaches a point where most new PCs come with high-quality, high-speed multimedia interfaces. When that happens, the market should turn toward the high-quality, 3-D graphics offered by high-end workstation companies such as Silicon Graphics. When we reach that point, the well-rendered, high-end graphics—like those used to make the movie *Jurassic Park*—will finally arrive on the desktop. ■

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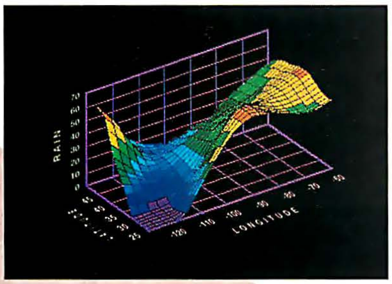
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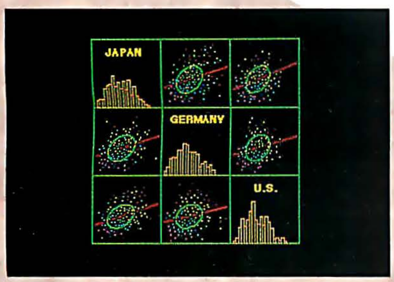
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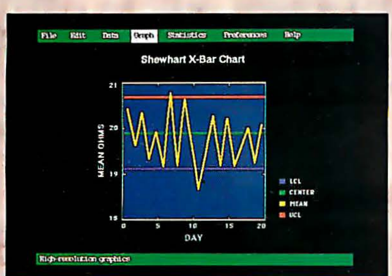
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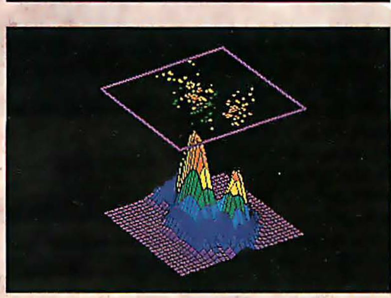
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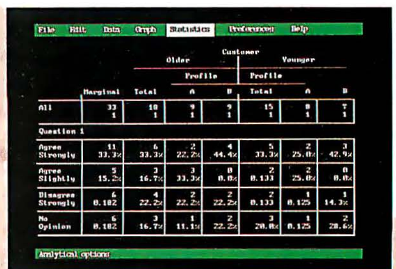












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Building SQL Front Ends

New versions of tools from Borland, Gupta, KnowledgeWare, and PowerSoft for building Windows database clients

RICK GREHAN

Shared databases are the lifeblood of modern corporations. Windows is the platform of choice among PC users. So Windows clients sharing an information repository maintained by a SQL database manager is an appealing model, and one that seems like a natural next step for companies seeking to automate their businesses. But I'll bet if you took a survey among programmers, asking them to name the applications that are the nastiest to build, you'd find Windows programs and SQL database client applications right at the top. Combine the two into a request for a Windows client for a SQL database server (or worse, a group of SQL database servers), and you are asking for trouble—at least if that programmer is armed only with a C compiler and Windows SDK (Software Development Kit).

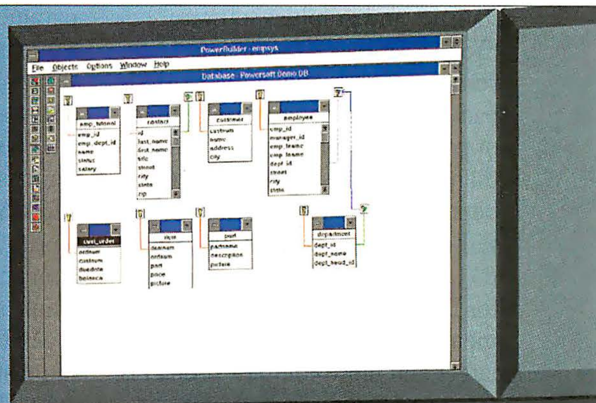
As usual, the right set of tools can make all the difference. The packages that I cover in this review—KnowledgeWare's ObjectView 2.1, Borland's ObjectVision Pro 2.0, PowerSoft's PowerBuilder 3.0, and Gupta's SQLWindows 4.0—all exist to reduce the trauma of building a Windows-based database application. Each provides a set of common interface elements (e.g., data-entry fields and check boxes) and a way of binding these elements to code that can communicate with a variety of database managers through SQL.

Common Tools

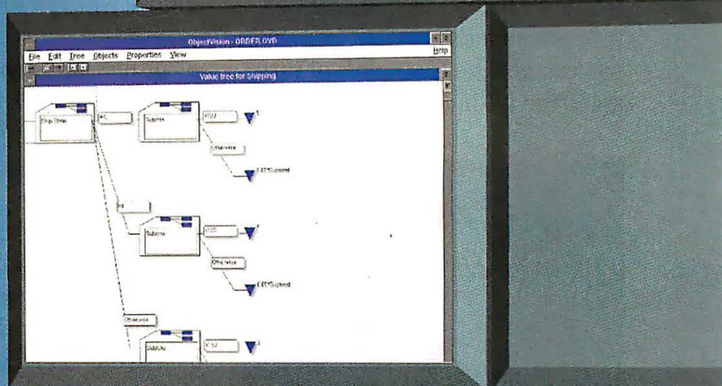
These four packages allow developers to build applications using more mouse than keyboard. In a sense, they are like specialized, souped-up resource toolkits. When you want to design a form, the front-end package opens a blank window and presents you with a smorgasbord of objects—entry fields, push buttons, check boxes, combo boxes, and so on—that you can place anywhere within the window. Click on a menu entry to select a push button; click over the form to deposit the push button; click on the push button to alter its properties.

Since your finished application must ultimately adjoin a database, front-end ap-

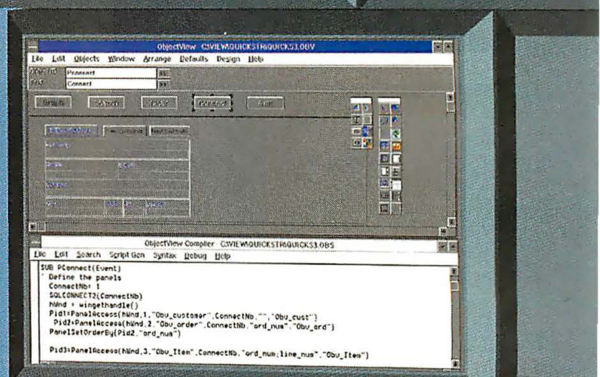
▶ **PowerBuilder's database painter provides a graphical view of database tables. Key fields are identified by an attached key icon. Foreign-key connections (such as between the department and employee tables) are shown by a connecting line.**



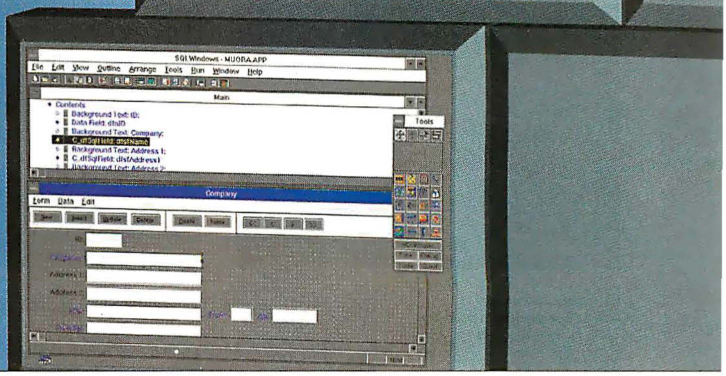
▶ **A program in ObjectVision is actually a flowchart (known as a *tree*). Here, a value tree attached to the shipping field determines the shipping charge based on the state.**



▶ **ObjectView's editor and compiler work in concert. The form under design appears in the upper window. The source code for handling events received by the connect button appears in the lower window. Note the floating tool palettes in the upper window; the smaller is a custom control.**



▶ **SQLWindows' outliner (upper window) and design window (lower window) track one another through the development process. Selecting an object in the form window synchronizes the outliner to the object's definition (highlighted in the upper window). SQLWindows also includes a floating tool palette (to the right of the design window).**



plications builders also include specialized objects for such work. One example is a data-entry field that must be connected to the back-end database and can carry along format and validation rules. Each of these packages also provides (in one form or another) a table object that allows manipulation of rows from a database table. The table is usually arranged in grid fashion, with column names across the top. In most cases, you can equip the tables with scroll bars. Most systems allow the user to manipulate the table's contents directly; the changes are automatically reflected in the back-end database.

Ultimately, some code has to get written somewhere—every menu you build graphically still needs a collection of methods to handle its events. But a good toolkit will make you write only as much code as is absolutely necessary. This is most true for generating SQL statements. PowerBuilder, especially, does a good job of building SQL SELECT statements automatically, loading them up with field names selected from database-table pick lists.

Although the front end works hard to shield user and developer alike from the actual database engine, that engine is an important consideration. Even now, the list of potential back ends is long, and providing support for a variety of database engines is not easy. The trend seems to be turning with the growing acceptance of Microsoft's ODBC (Open Database Connectivity) as a common access layer for database back ends. However, among these packages, only ObjectView and PowerBuilder support ODBC; the others (primarily for performance considerations, according to their developers) write directly to each back-end database they support.

ObjectView 2.1

- **Development language uses an easy-to-master BASIC-like syntax.**
- **Graphics engine provides a variety of business graphics styles.**
- **Supports numerous back-end databases.**
- **Includes no support for version control.**
- **Includes only a rudimentary object-repository system.**

ObjectView is indeed an object-oriented system. The topmost object in the ObjectView hierarchy is the *form*, which is more or less synonymous with *application*. A form consists of one or more panels (where a panel is a view of a result set from a database) and includes data-entry and display fields.

When you build an application in ObjectView, you wind your way through three separate programs: ObjectView's editor, the data modeler, and the compiler. Typically, you open a blank form in the editor and then move directly to the data modeler to select which tables will contribute data to or receive data from the form.

Once you've selected the database fields that will appear in the form, the data modeler automatically loads entry fields into the form (thus creating a panel) and returns you to the editor. The entry fields are loaded vertically in the form from top to bottom; you design the application's final layout by simply picking up each field and putting it where it belongs.

At any time in the editor, you can also add push buttons, check boxes, text, and even bit maps. Clicking the right mouse button while an object is selected will summon a pop-up menu that lets you alter that object's attributes, such as color and typeface. If the selected object can be manipulated by the user, this pop-up menu also leads you to a dialog box, where you indicate not only the events that the object responds to but also the method that manages that object's behavior. Some methods are built into ObjectView; for example, an EXIT push button might simply issue the CLOSE event, which will terminate the application.

For less trivial objects, you would enter SCRIPT for the method name. You must then slip out of the editor and slide into the compiler to compose the method code in ObjectScript, ObjectView's BASIC-like programming language. Programming in ObjectView is close to pure point-and-click, thanks to the hand-holding provided by the ObjectView compiler's editing menus and dialog boxes.

You build the subroutine body by more clicks in more pop-up dialog boxes. In most cases, ObjectView provides you with pick lists of appropriate ObjectScript functions. If you select a function from the pick list, a comment window appears that not only tells you what the function does, but also displays the command syntax in a special editing box. This syntax box actually acts as a template: You can overwrite the dummy arguments that appear in the function description and then cut and paste the result into your program.

ObjectView's ability to handle master-detail forms (such as might appear in an order-entry application) is particularly good. The data modeler uses a drag-and-drop paradigm to manage table joins. Within the data modeler, you select the tables that will participate in the application from a combo box. Child windows open for each table. To indicate the join, you grab the field from the first table's window, drag it to the window of the second table, and drop it over the join field. ObjectView signals the link by drawing a line between the appropriate tables. You can modify the details of the link to define a one-to-one, one-to-many, or many-to-one link.

ObjectView's table object manipulates multiple database rows. In an application, a table appears as a grid of rows and columns, its contents typically filled with the results of rows drawn from a database table. However, ObjectView also offers a special superset of the table object: the spreadsheet object. This object provides a remarkable amount of spreadsheet functionality. Users can edit cells and add formulas much as with any other spreadsheet.

ObjectView's graphics server object can produce up to 14 different graphs and charts. Along with the standard graphs (e.g., pie, 3-D pie, and bar), the graphics server can produce more esoteric graphs: polar graphs and Gantt charts, for example.

Back-End Support

ObjectView supports a stunning array of back-end database packages. Most of this connectivity is available thanks to the Q+E Libraries (available from Q+E Software) and Microsoft's ODBC. This results in a hodgepodge of access and concurrency mechanisms. Earlier versions of ObjectView provided more manifest connectivity to dBase files, so ObjectScript still retains functions explicitly to manipulate such databases; for example, you can lock individual records or entire files. Besides dBase, ObjectView also provides Btrieve-specific functions. You can lock or unlock individual Btrieve records, and Btrieve supports transaction control, accessible through ObjectScript calls.

ObjectView still has plenty of SQL connectivity, however. In fact, while manipulating dBase or Btrieve files, an ObjectView application can be carrying on operations with up to eight simultaneous SQL connections. ObjectView even provides a number of Oracle-specific commands, including the binding mechanism for associating ObjectScript variables with placeholder variables that you can insert directly into SQL statements. Most important, the SQL functions provide direct access to commit/rollback functions.

Like SQLWindows and PowerBuilder, ObjectView lets you construct classes and

COMPARING SQL CLIENT DEVELOPMENT SYSTEMS

A blow-by-blow comparison of features for front-end builders can boil down to a comparison of concurrency mechanisms, back-end support, and price. But keep in mind that the quality of the development environment, where SQLWindows and PowerBuilder excel, can't be easily captured in a tabular comparison. (● = yes; ○ = no.)

	OBJECTVIEW 2.1	OBJECTVISION PRO 2.0	POWERBUILDER 3.0	SQLWINDOWS 4.0
Database support				
BTrieve	●	●	○	○
DB2	●	○	●	[1]
dBase	●	●	○	○
Gupta SQLBase	●	○	●	●
Informix	●	○	●	[1]
Ingres	●	○	○	●
NetWare SQL	●	○	○	●
ODBC	●	○	●	○
Oracle	●	○	●	[1]
Paradox	●	●	○	○
Q+E Libraries	●	○	○	○
SQL Server	●	● (via DLL)	●	[1]
Teradata (NCR 3600)	●	○	○	○
Quadbase SQL	●	○	○	○
XDB	●	○	●	○
Watcom SQL	●	○	●	○
ASCII	●	●	○	○
Development languages				
Custom language	○	●	○	●
C/C++	○	●	○	○
BASIC	● [2]	○	● [2]	○
Data types				
Fixed-length character	●	●	○	○
Variable-length character	●	●	●	●
Integer	●	○	●	Number
Floating-point	●	●	●	Number
Date	●	[3]	●	[3]
Time	[4]	[3]	●	[3]
Binary object	●	○ (dBase III memo fields)	○	●
Security/concurrency				
Explicit row locking	● (dBase)	○	[5]	[6]
Explicit table locking	● (dBase)	○	[5]	○
Automatic locking	● (dBase)	○	[5]	●
Transaction rollbacks	●	[7]	●	●
System requirements				
Memory (MB)	8	2	4	8
Disk space (MB)	40	10	12	12
Miscellaneous				
Ad hoc SQL queries	●	○	●	●
Debugger	●	○	●	●
Object repository	○ [8]	○	●	●
User-generated DLL support	●	●	●	●
Graphics generation	●	○	●	●
OLE support	●	●	●	●
Price	$2799 [9]	$495	Single back end: $3595 With ODBC: $3195	Corporate: $3495 Standard: $1995

[1] Requires an additional router package.
[2] Similar to BASIC but includes nonstandard features.
[3] Single time/date data type.
[4] Time data handled as strings.
[5] Through ODBC only; subject to ODBC driver.
[6] Isolation levels.
[7] ObjectVision does support SQL connectivity through a DLL.
[8] Rudimentary object-storage tools but no version control.
[9] Development system only; distributing run times requires additional licenses.

instantiate objects based on those classes (e.g., a data-entry field). But SQLWindows and PowerBuilder also let you create *object repositories*—databases that can hold bits and pieces of an application such as push buttons, entry fields, panels, and entire forms. The closest ObjectView comes to any kind of repository is the mini-album and object manager applications.

The mini-album holds clip-art-type graphics (Windows-compatible bit maps or vector images). The object manager is a similar kind of clipboard-style holding tank. You can, for example, copy button and field objects out of your application and place them in the object manager for later use. The object manager will remember not only the image of the object (e.g., color and font) but also other attributes (e.g., methods).

New in version 2.1 is an improved interface to C and C++ (the documentation gives examples for interfacing to Microsoft C/C++ 7.0, Quick C, Visual C++ for Windows, and Borland C/C++ 3.1). All in all, ObjectView is a capable package. The only thing really missing is a good object repository with version control capabilities. Engineers at KnowledgeWare informed me that this was on the way; I'll be watching.

ObjectVision Pro 2.0

- **Bundled with Turbo C++ and ObjectWindows.**
- **Programming is graphical.**
- **Has limited concurrency controls.**
- **SQL connectivity is not well integrated; SQL access is through a DLL.**
- **Least expensive package; targeted at less experienced developers.**

ObjectVision is a graphical tool for constructing applications, which are collections of forms. In ObjectVision, *form* is really just another word for *data-entry screen.* You can populate forms with the usual array of user-interface objects: entry fields, push buttons, tables, and bit maps.

If there's an overriding principle behind ObjectVision, it's the notion of *goal-directed* or *guided* completion. Simply put, this means that an applications designer does not have to explicitly specify the execution path through a form. All forms in an application reside on the *form stack*, a kind of internal data structure that isn't much more than a list of form names. The topmost form in the form stack is referred to as the *goal* form. It is ObjectVision's ultimate aim to fill all unfilled fields in that form.

As an ObjectVision application executes, guiding the user from one entry field to the next and encountering fields that depend on values from other forms, ObjectVision calls up the forms on which each field depends. This nesting goes arbitrarily deep into the form stack, and ObjectVision keeps track of the nesting path. The application is considered complete when all entry fields on the goal form are filled.

Of course, you can override ObjectView's guided completion by attaching code to a form's data-entry fields and other user-input objects. Here's where ObjectView diverges from the pack; programming in ObjectView is more an act of drawing than of writing.

Rather than type in lines of source code, you construct *trees*, a specialized form of flowchart. There are two kinds of trees in ObjectVision: event trees and value trees. Event trees specify how an object responds to a particular event (e.g., what happens when you click on a button); value trees define what actions are taken when a value is placed in a field. As an example, a value tree attached to a subtotal field could examine the subtotal amount and determine whether to apply a discount to the entire total.

Connections between fields in ObjectVision programs and data in databases occur via links. A link defines how data flows into or out of an ObjectView application. Thus, a link might also connect an ObjectView application to another application via DDE. Currently, ObjectView supports links to five external sources: dBase, Paradox, Btrieve, ASCII, and DDE. The SQL connection takes place through a DLL.

The act of building links sends you through a series of dialog boxes. When you're done, you've assigned connections between fields in the database and fields in the form. In the process, you identify which fields are read from the database and which fields are written. You can also have ObjectVision build database navigation buttons for you automatically—creating all the necessary support code—and deposit those buttons into your form.

Although links are easy to define, their static nature makes for some limitations. Specifically, when you build a link, you have to define the path to the database files. This path definition stays in the final application, which means that the target system must have an identical directory structure to the development system. The only workaround is to define logical drives using the DOS ASSIGN command.

Split Access

ObjectVision's commands for accessing SQL databases are separate from those commands that access Paradox, Btrieve, dBase, and ASCII files. ObjectVision's SQL awareness comes via a DLL that your application must load and register (i.e., build structures that "teach" ObjectVision how to call entry points in the DLL).

On the one hand, this means that Paradox databases, for example, are accessed directly as Paradox databases, not through an additional layer that makes Paradox files look like a SQL database. The absence of the additional layer certainly results in higher throughput. However, it makes it difficult to create back-end-independent packages in ObjectView, since database functions being called are either SQL-type functions or non-SQL-type functions. Furthermore, you can't create links between SQL tables and ObjectVision fields using the dialog boxes provided in ObjectVision (as described above). Instead, you have to hand-code the links using the `@SQLOPEN()` function.

ObjectVision's concurrency mechanisms are rudimentary. The only concurrency ObjectVision understands is the *dirty read*. It works like this: Whenever your application requests a record from the database, the ObjectVision engine takes a snapshot of the record before handing it to the application. After the user has made modifications and the application issues a write request, ObjectVision checks its snapshot with the copy of the record in the file. If ObjectVision finds any differences—indicating that another user has modified the record behind your back—it asks whether the write request should be aborted. ObjectVision supports no record locking (even though those capabilities are within Paradox, dBase, and Btrieve) and, even worse, provides no commit/rollback capabilities. (If you use SQL within ObjectView, you can issue any commit and rollback commands that are provided by the SQL engine you are attached to.)

There's plenty of room for improvement in ObjectVision. The version I tested incorporated a version of the Paradox engine that was not up to date. Borland rightly points out that ObjectVision is targeted toward entry-level developers who may not have the skills for managing large or complex databases. Users requiring a more industrial-strength database applications builder from Borland will likely opt for Paradox for Windows, which should include SQL connectivity by the time you read this.

PowerBuilder 3.0

- **Development language is like BASIC.**
- **Development environment provides good isolation from SQL.**
- **Object repository system is not as well developed as SQLWindows'.**
- **Watcom SQL is bundled with the package.**
- **PowerBuilder applications can also include dynamically generated business graphics and charts.**

As I write this article, PowerSoft's PowerBuilder has just undergone a major face-lift, moving up from version 2.0 to 3.0. I worked with both releases but concentrated on 3.0 (unfortunately, 3.0 documentation was still at the presses).

Because of an effort to drive home the graphical nature of the PowerBuilder environment, every program in the suite is a painter: There's the application painter, the window painter, the menu painter, and even a database painter. Each is a separate object-building application within the PowerBuilder suite. For example, you open the structure painter to build frequently used data structures for later entry into modules that you create in PowerScript (PowerBuilder's BASIC-like application language). These data structures have a format similar to C's `struct` or Pascal's record data structures.

Like ObjectView, PowerBuilder is compatible with a surprising number of database back ends. In addition, PowerBuilder arrives bundled with the capable Watcom SQL engine (to which it talks via ODBC). Included are Watcom's database tools, which can handle rudimentary SQL database creation and maintenance activities, as well as provide an interactive SQL screen for ad hoc queries.

PowerBuilder's standard control is the PowerBar, a row of icon-bedecked push buttons that provide instant access to PowerBuilder's various painters. The PowerBar is customizable: You can add new icons (PowerBuilder provides 80) and attach applications to each. A single click can transfer you to your favorite editor. If you don't like the PowerBar approach, you can revert to the PowerPanel, which displays as a child window populated with regular Windows icons.

Constructing a PowerBuilder application typically begins at the database painter, where you create and manipulate database tables. The database painter represents foreign key connections graphically, much in the way ObjectView displays joins in

its data modeler. A line connects the corresponding fields. From the database painter, you can also store validation rules and display styles in the database.

Next is the application painter, which builds the root entity from which all other objects in the application spring. Although the application object has no visible counterpart in the final executable file, it holds guiding scripts that determine how the windows in the application interconnect.

As you might expect, the window painter is PowerBuilder's editor for building windows and populating them with interface objects such as push buttons, check boxes, and (among others) PowerBuilder's most powerful interface object, the datawindow. The datawindow is PowerBuilder's answer to ObjectView's panel and SQLWindows' QuestWindow; it is the means by which data moves between the application and the database.

A datawindow has a great deal of flexibility, thanks largely to its eight presentation styles. Tabular presentation style displays rows in columns in the familiar grid fashion; free-form style lets you position database fields haphazardly (if you choose) within the window. Other styles include grid (tabular style with lines), labels (for printing labels), and even group (which lets you arrange fields for subtotals). Finally, the graph presentation style connects the datawindow to PowerBuilder's graphing capabilities and allows the application to display data in one of over a dozen graph styles (both 2-D and 3-D).

As usual, there's code behind the window. As with many of the other packages, whenever you click the right mouse button over a datawindow object, a floating menu appears. Topmost in that window is the selection script. Click on that, and you're taken to a window from which you can select all the source code for the methods associated with that datawindow. Each event that a datawindow might accept (e.g., a click within the window or an item changed) can trigger a different script. Select the event, and the window displays the code that will be triggered in response to that event. Of course, you can attach a script to any kind of object that might respond to an external action.

PowerBuilder's debugger is full-fledged. You can deposit breakpoints in selected scripts. Then, when you execute the application, the debugger halts the application at the appropriate point and opens a debugger window. From there, you can open a watch window to keep an eye on global or local variables.

Library Painter

PowerBuilder has an object repository, called the *library painter*, that can hold various application objects: datawindows, menus, functions, even whole applications. The library database, which can reside either locally or on a network, maintains a checkout/check-in facility. If you check out an entry for modification, no one else can check out (and therefore modify) that entry until you check it back in again.

Upon first opening the library painter, you'd swear you were in the Windows file manager. You see a tree diagram of subdirectories represented as folders; double-clicking on a folder expands that branch of the tree. The library manager takes this metaphor all the way into libraries: If you double-click on a library icon, it opens to reveal that library's contents. Each object has its own icon. Furthermore, you can see modification dates and times, as well as one-line comments that can be attached to each object. All this fits seamlessly within the graphical display structure you've become used to in the program manager.

Within the library painter, you can search a library (or a portion thereof) for a specific string. The results of the search will be displayed in an annotated pick list. Click on an entry of the pick list (which, again, could be any kind of object), and PowerBuilder sends you directly to the proper painter for the object.

PowerBuilder works hard at doing your programming for you. It's rapidly acquiring as much back-end capability as ObjectView (3.0 adds ODBC). PowerBuilder is in hot competition with SQLWindows, and it will be interesting to watch the rivalry as version 3.0 moves to completion.

SQLWindows 4.0

- **Provides extensive team-programming and project-control tools.**
- **SQLBase back end is tightly coupled with the front end.**
- **Object-oriented programming constructs allow reuse and inheritance.**
- **SQLWindows Application Language is difficult to master.**
- **Quest development tool allows rapid creation of database objects within a form.**

Gupta SQLWindows is the most robust development package. It's available in two editions: the standard edition ($1995) and the corporate edition ($3495). The corporate edition has a host of tools, most notable among them being SQLWindows, TeamWindows, Quest, ReportWindows, SQLTalk, and (of course) the SQLBase server. The standard edition includes all the above except for TeamWindows and Quest. I reviewed the corporate edition.

When you launch the SQLWindows development system, you actually open two windows into the application. One, the form-design window, allows you to graphically populate the form with user-interface objects in much the same way as the other packages do. A typical procedure is choosing the push-button icon from the floating tool palette and clicking on the form, where a push button then appears.

The other window into the form is the outliner, where the text for the SAL (SQLWindows Application Language) code associated with the window resides. The two windows are tightly coupled: Place a new object in the form window, and the proper SAL code automatically appears in the outliner. Activate a menu in the form window (you're still designing, mind you), and the line corresponding to the SAL code that defines that menu entry is highlighted in the outliner.

Quest, Gupta's graphical query, editing, and reporting tool, is also closely tied to the SQLWindows development environment. This linkage takes place through the QuestWindow object. It lets you build database access panels for either querying or editing a data file. While you build your query/edit child window, Quest generates SAL code for you automatically. Once you've built the QuestWindow, you can customize its behavior by programming SQLWindows directly. You can, of course, operate Quest as a separate product, for graphically generating everything from queries to reports.

TeamWindows is SQLWindows' project management system. A project is a conglomerate of application code modules, some non-SQLWindows objects (e.g., bit maps), an application database, project standards (which can be anything from coding standard to default object names), and a project manager and staff.

In TeamWindows' administrator component, you create and maintain users and projects. This amounts to working with a specialized database. One piece of this database is the data dictionary, which carries information about the structure of databases within applications. This information is extensive and falls into three categories: SQL attributes (e.g., data type and field length), SQL Windows attributes (e.g., font and color), and user-defined attributes (e.g., free-form comments) that

can be attached for later referral.

TeamWindows' checkout/check-in facility provides version control for large projects involving multiple developers. To work with an application's modules, you must extract them from whatever project's library the application is a member of. This moves them into your personal workspace and tags them as being logged out; no other developer on the project can alter those modules until you check them back into the library. Users within TeamWindows are assigned access levels and promotion levels. The access-levels attribute (there are four levels) defines what a user can do within the TeamWindows environment—that is, what parts of the TeamWindows database the user is able to alter. For example, only a project administrator is allowed to create new projects.

The promotion level indicates the privileges that the user has within the TeamWindows promotion facility, which is the mechanism by which TeamWindows manages the status of project components as they pass through design phases. TeamWindows recognizes three levels in the life cycle of a program module: the development level, the testing level, and the production level. In a nutshell, a program module begins in development. From there, it moves into a testing phase. After verification, the module may be promoted into the production phase.

There are actually parallel paths in the testing phase. TeamWindows recognizes that some modules may be tested in standalone fashion, as part of a single application, while other modules may be tested in multiple applications. Hence, TeamWindows provides a shared testing phase.

SQL and SAL

SQLWindows expects only a SQL back end, so it doesn't have any of the dBase- or Btrieve-like explicit record-locking commands that you will find in ObjectView. However, SQLBase does provide a kind of implicit row locking via *isolation levels*, which can be set using the SAL function `SqlSetIsolationLevel()`. Although there are four isolation levels, the basic function of the level is to determine whether an automatic lock is placed on rows that your application accesses during a transaction. This permits you to manage the level of concurrency an application can handle. There is, of course, also the standard SQL commit/rollback mechanism for managing transactions.

As good as SQLWindows and Quest are at rapidly building forms, sooner or


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later you have to deal with code. SAL is a departure from typical programming languages, not only in syntax, but also in the method by which you create SAL code. Programming in SAL involves working with a *folding editor*, which is like an outline processor. The SAL code that manages an application is often referred to as the *outline*, and the window in which the outline is displayed as the *outliner*.

Recall that the outline window and the form-design window in SQLWindows run in parallel. Changes that you make in the form-design window are instantly reflected in the outliner. Similarly, if you add a new object to the outliner, it appears in the form window. Object attributes that are not specified in the outline are available via a pop-up menu that you conjure with a mouse-click over the object in the form window or over an icon that appears next to the object name in the outline.

For example, at one level of the outline you'll find an entry named *menus*. Double-click on that entry and the level below opens, revealing entries for all the menus in the application. Select one, click on it, and the next level opens, exposing information about the selected menu, including its title, its description, and a list of menu items. Of course, the menu items themselves have more information hidden at lower levels; you can access that information by clicking on the items.

This approach has a number of advantages. Most visibly, it takes top-down programming design to the extreme. You can zoom in to focus on only the portion of the program under construction, or zoom out to examine the overall flow of the program. Since the entire format is nonprocedural by nature, it fits in well with the event-driven structure of Windows programming. Finally, when you add an object to a form under construction, not only does SQLWindows automatically load the proper source into SAL, but it also attaches the necessary subheadings for that object.

SQLWindows is undeniably one of the most capable front-end development packages. Furthermore, since Gupta provides a strong back-end SQL engine (SQLBase), the pairing is more solid (i.e., if a function is there, it's really there, rather than available only if the engine sitting on the other side of ODBC supports it), and the documentation for the database administration is thus more complete.

> **SQLWindows is undeniably one of the most capable front-end development packages.**

Straining Under Complexity

SQL front-end development packages sit at the collision point of two very complex activities: building a Windows application and building a SQL database application. Consequently, their raison d'être is an attempt to simplify both activities. Sometimes, this attempt results in bizarre overachievements—the GUI philosophy carried to near unusability, you might say.

Programming in ObjectVision (high-level programming of form mechanics; that is, not using Turbo C++ to build a DLL) amounts to building a flowchart. Personally, I don't see that this process is any easier than simply writing code. Is all the mouse-clicking really faster than typing in an IF... THEN statement?

Perhaps I suffer from my nongraphics programming roots, and perhaps ObjectVision's paradigm is something that a nonprogrammer would cotton to quickly. But in my experience, programming in ObjectVision is ultimately no faster or easier than programming in other packages.

Two more examples of the GUI straining under complexity come from ObjectVision and PowerBuilder. If you are building an ObjectVision application and you need to select an entire table, you have to click on an entry twice... slowly. A standard double-click will not work—that does something else. The slower double-click forces you to hit your mental brakes and unfortunately expands the universe of user interactions that you have to master in order to deal with the application. Meanwhile, PowerBuilder's primary user interface, the PowerBar, can sometimes stretch from near the top of the screen to the bottom. The visual effect is a long column of minuscule icons.

Making Ends Meet

Probably, neophyte applications developers will gravitate toward ObjectVision. Of course, as the demands you place on your application grow, ObjectVision's limitations will make themselves apparent. In particular, if your database either sees significant multiuser activity or is not already in one of the data file formats that ObjectVision supports directly, you should look elsewhere.

ObjectView stakes out a solid position on middle ground. It talks to just about any database you can think of, supports plenty of visual interface objects, and uses a programming language that's easy to pick up even if your only programming training has been in BASIC.

My guess is that SQLWindows and PowerBuilder will continue elbowing one another for position as the premier development platform for serious Windows SQL applications builders. Although it's difficult to make a comparison with PowerBuilder in the midst of a revision, SQLWindows enjoys a more complete and better-integrated object-repository and project-control system.

Furthermore, SQLWindows has the advantage that the front-end application builder comes from a company with a very popular database back end. On the one hand, this means it's less likely that SQLWindows will have the widespread back-end support that PowerBuilder has (via ODBC). On the other hand, it gives the developer working against Gupta's back-end database greater control over the entire system. And simply put, it's always best when your front end knows precisely what your back end is doing. ■

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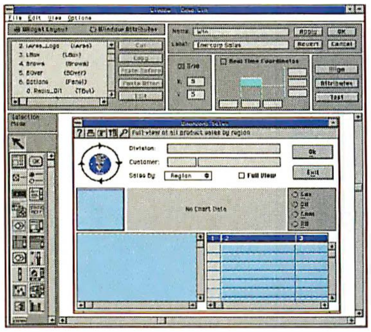
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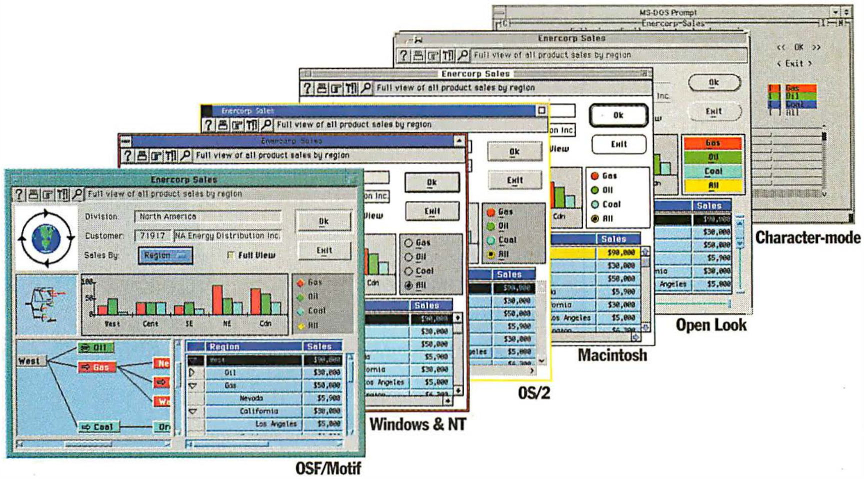
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Windows Under 4 Pounds

New 486-class subnotebooks from Epson and IBM offer alternatives to Intel CPUs and include the kind of features found in heavier models

DAVE ROWELL

The guiding idea behind subnotebooks has been compromise on features to shed pounds. The result is systems under 4 pounds but with external floppy drives and less processing power, smaller screens, cramped keyboards, shorter battery life, and higher prices than standard notebooks.

If Windows is your yardstick, the lack of processing power is perhaps the most significant compromise. However, several recent subnotebooks, including two from Epson America and IBM, employ 486 or 486-like processors that are fast enough for good Windows performance.

Along with the claim of 486 power, Epson's ActionNote 4000 and IBM's ThinkPad 500 both provide features more often found in heavier notebooks—4 MB of RAM, an 85-MB hard drive, and a backlit VGA screen—for just under $2000. I reviewed production units with these standard hardware configurations (except that the ThinkPad I evaluated came with an optional 170-MB Western Digital Caviar Lite hard drive).

Both Epson and IBM make acceptable subnotebooks. However, the ThinkPad comes out ahead based on both performance and usability, although it costs slightly more and has fewer bundled extras than the ActionNote.



New subnotebooks *from IBM (left) and Epson America. Both run Windows easily, but IBM's ThinkPad 500 sets new usability and performance standards for this class.*

What's in a 486?

If "486" means "Intel" to you, then the Epson and IBM subnotebooks are 486 PCs in name only. The ActionNote uses a 33-MHz Cyrix 486SLC, while the ThinkPad runs IBM's speed-doubled 25-/50-MHz 486SLC2. At comparable clock speeds, neither gives you the all-around performance of an Intel chip, and neither provides a built-in FPU. (The ActionNote can take an optional Cyrix 387SL math chip.) For comparison, I used CompUSA's 4SL/25 Subnote, which runs Intel's 25-MHz 486SL (see "The Littlest Notebooks," September BYTE).

Consider Cyrix's 486SLC chip as sort of a 386-and-a-half. It benefits from pipelined execution, a built-in 1-KB cache, and a hardware multiplier that greatly speeds up integer math operations, such as spreadsheet recalculations. With its 386SX pinout, however, the 486SLC suffers from a constricted 16-bit path to DRAM. Intel's 486 chips use an 8-KB cache and a full 32-bit external data path. Even at 33 MHz, the ActionNote's raw CPU performance, as measured by BYTE's low-level DOS tests, is less than two-thirds that of the Subnote with its 25-MHz Intel 486SL.

Not related to the Cyrix 486SLC family, IBM's 486SLC provides performance closer to that of an Intel 486 of comparable clock speed. The ThinkPad makes up the difference and a little more by using a speed-doubled version, the 486SLC2, which runs internal operations (including an 8-KB cache) at 50 MHz.

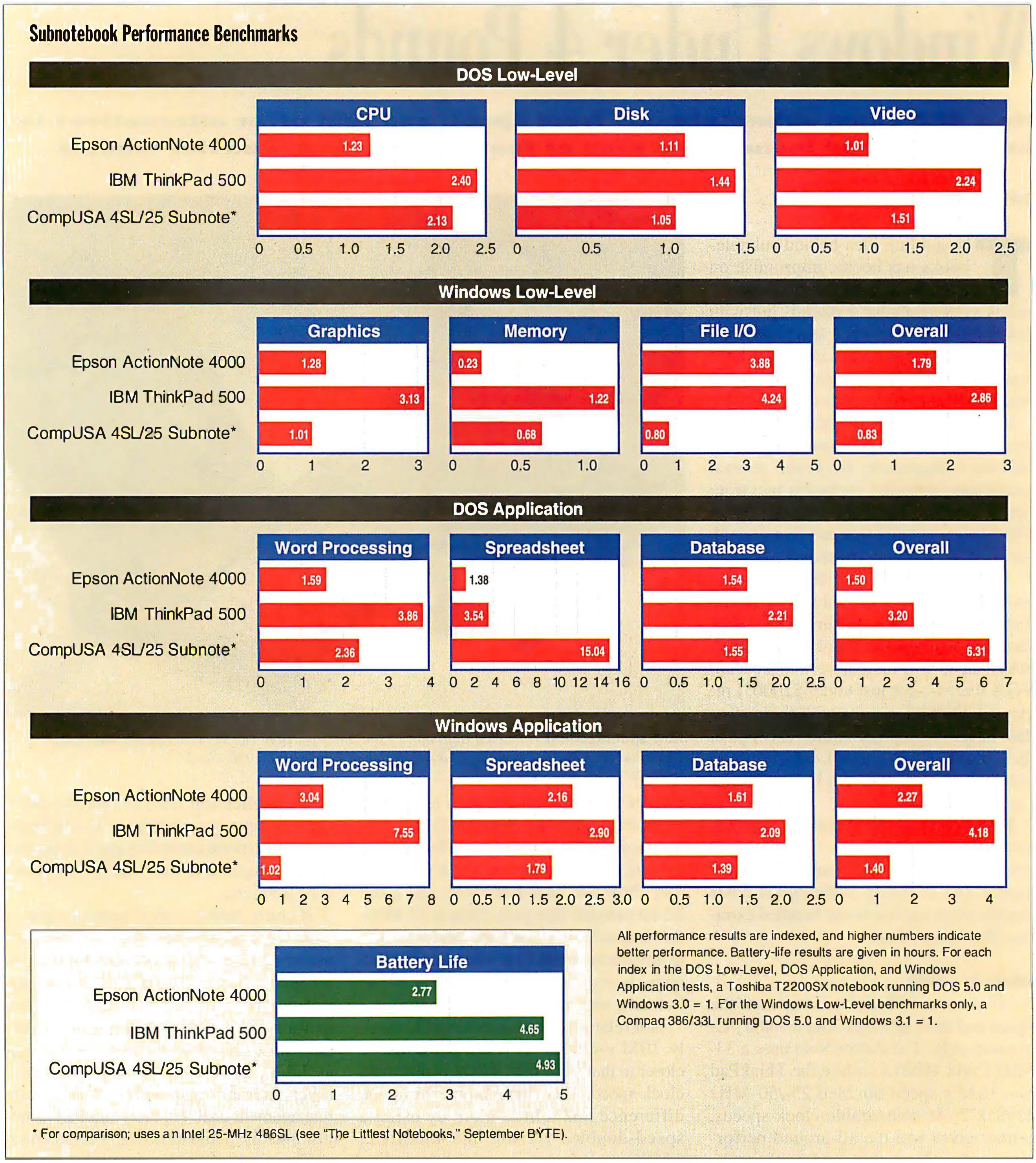
The video and hard drive subsystems also play a big part in performance. In spite of its slower CPU, the ActionNote provides decent Windows graphics performance and did better in the Windows applications tests than the Subnote—but not as well as the ThinkPad, which gave superior performance in all hardware categories. The ThinkPad pulled way ahead in all application tests except the DOS spreadsheet section, where its lack of built-in floating-point capability put it at quarter speed compared to the Intel 486SL–powered Subnote.

If chips ending in SLC aren't as fast as their Intel namesakes, they are smaller, use less power, and run cooler. Running at 50 MHz, IBM's 486SLC2 needs no heat sink or fan even though it's lodged in close quarters. The chip is a power miser to begin with and keeps even cooler by running at 3.3 V, as do most of the ThinkPad's other internal components. With power management enabled, the ThinkPad lasted just over 4½ hours in BYTE's battery test.

Cyrix's 486SLC has a similar reputation for low power consumption, but the ActionNote runs it at 5 V, and the CPU's position close beneath the machine's outer skin creates a surprisingly warm spot on the bottom of the case. Battery life was under 3 hours.

Epson ActionNote 4000

Epson's ActionNote 4000 provides a mixture of strong and weak features and so



Although the ActionNote's *33-MHz Cyrix 486SLC provided 486-class integer performance, its 16-bit external memory bus lowered its DOS Low-Level CPU score to almost half that of the 25-MHz Intel 486SL in the CompUSA Subnote (provided for comparison). Similarly, the ThinkPad's 50-MHz IBM 486SLC2 didn't provide double the CPU score of the Subnote's 25-MHz 32-bit Intel chip. Disk and graphics performance was more important than CPU speed for the application tests. The ThinkPad excelled everywhere except in floating-point math, and the ActionNote beat the Subnote in Windows testing.*

comes out an average player in the subnotebook game. Its strong points are its sharp, paper-white LCD, smooth typing action, and a hard drive that can be removed as a cartridge. The ActionNote also comes with a carrying case, which is a $79 option with the ThinkPad. The machine's weak points are its keyboard's nonstandard layout, a hard-to-use tiny trackball (like most found in subnotebooks) located to the right above the keyboard, short battery life, and an underdeveloped set of power management features.

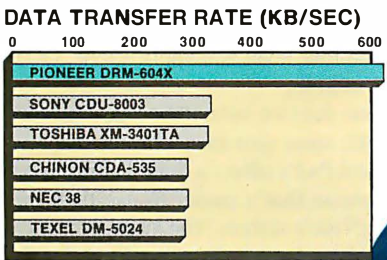
The ActionNote's LCD screen appears to be the same 7.4-inch panel used in the ThinkPad. Although small (I measured the actual display area as 7¼ inches diagonally), the display is bright, sharp, and easy to

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The sliders to adjust contrast and brightness don't move smoothly, but they work. (This condition characterizes other components of the ActionNote's case design, such as the battery and the hard drive latches. The machine doesn't have the overall fit and finish of, for example, a Toshiba notebook.) The doors to the back ports and to the Type II PCMCIA slot are hinged and therefore susceptible to breaking off.

The ActionNote's keyboard has a smooth, pleasant typing action. Although the keys are spaced closely together in typical subnotebook fashion, most people will be able to touch-type easily. What I don't like is the placement of the reduced right Shift key—one space further to the right and close over the cursor keys—so that I was just as likely to hit the up arrow as the Shift key.

The removable hard drive makes it feasible for the ActionNote to be shared among several people, each with his or her own drive cartridge, as well as lockup data security. Currently, the review unit's 85-MB hard drive (made by Toshiba) and a larger 120-MB drive ($220 more) are the only drive options available from Epson, and there is as yet no third-party support.

Besides a math chip, you can add memory to a maximum of 8 MB. Other expansion options are limited to what you can attach to a standard-size parallel, mouse, or serial port, or insert in the single Type II PCMCIA slot. The ActionNote comes with drivers that provide PCMCIA 2.01 Card and Socket Services. Newer cards with drivers that also meet this software standard should work; all will, eventually. Older cards that don't meet this standard may not work, because the ActionNote uses a Databook PCMCIA controller chip rather than the Intel chip that most cards with older drivers support directly. Epson sells several types of PC cards that do work in the ActionNote.

SUBNOTEBOOK FEATURES

Epson's ActionNote 4000 and IBM's ThinkPad 500 have several similarities besides small size and light weight. In addition to identical RAM, hard drive, and display configurations, both provide a small 3½-inch external floppy drive and a Type II slot that meets the latest PCMCIA 2.01 standard. The ThinkPad has the faster CPU, while the ActionNote provides for a math-chip upgrade. (Neither CPU provides built-in floating-point capability.) The lower-priced ActionNote comes with Windows 3.1 installed and a carrying case.

	EPSON ACTIONNOTE 4000	IBM THINKPAD 500
CPU	33-MHz 486SLC	25-/50-MHz 486SLC2
RAM	4 MB (up to 8 MB)	4 MB (up to 12 MB)
Storage	85-MB internal IDE (removable)	85-MB internal IDE (170-MB unit reviewed)
Video	64-gray-scale backlit monochrome LCD	64-gray-scale backlit monochrome LCD
Viewable display size (inches diagonally)	7.25	7.25
Resolution (pixels)	640 × 480; 800 × 600 (external)	640 × 480; 800 × 600 (external)
Size (inches; H × W × D)	1.5 × 10 × 7.6	1.6 × 10.1 × 7.2
Weight (lb.; with battery)	3.8	3.8
Expansion	PCMCIA 2.01 Type II slot; math socket for Cyrix or Intel 387 chip; external 3½-inch floppy drive	PCMCIA 2.01 Type II slot; external 3½-inch floppy drive
Price	With 85-MB drive: $1949 With 120-MB drive: $2169	With 85-MB drive: $1999 With 170-MB drive: $2499

The ThinkPad's hard drive and video systems provide exceptional performance.

The 3½-inch floppy drive cable attaches to both the keyboard and parallel ports, an unusual arrangement providing a pass-through connector for the keyboard/mouse port only. In contrast to the ThinkPad's floppy drive, the ActionNote's drive has a fold-down stand that makes it easier to insert and remove floppy disks.

Compared to the ThinkPad's, the ActionNote's power management options are limited. You can set a hard drive and a total system time-out. In addition, you can press a function-key combination to enter suspend mode, though not from within Windows. And closing the lid puts you in standby mode under all conditions. Setting power options is inconvenient because you can enter setup only during the boot-up sequence. The ActionNote's nickel-cadmium battery lasted only 2¾ hours under power management.

The ActionNote provides preloaded Windows and the padded carrying case; both are optional with the ThinkPad. The carrying case has just enough space to hold the ActionNote, the external floppy drive, manuals, and an AC adapter with cables. A last plus is Epson's Extra Care Road Service, which provides overnight replacement of the unit with all shipping costs paid by Epson. You can keep your data by removing the old hard drive and installing it in the new system (if the problem isn't with the drive itself).

IBM ThinkPad 500

There's more to like and less to dislike about IBM's ThinkPad 500 than there is about Epson's ActionNote. Performance is at the top of the list. In addition to the fast speed-doubled CPU, the ThinkPad's hard drive and video systems provide exceptional performance for a system without graphics acceleration. The ThinkPad zipped ahead of the ActionNote in all the BYTE benchmarks—low-level and applications, DOS and Windows.

While the two subnotebooks appear to share the same nice monochrome display, the ThinkPad's offers a digital adjustment mechanism that's easier to use than the ActionNote's sliders. The keyboard has a great layout for a subnotebook; it closely resembles that of larger notebooks. I liked the ActionNote's typing action better, but I'd rather use the stiff-typing IBM keyboard because of its layout. The compromise that allows this relatively luxurious key layout is foreshortening of the function keys (F1 through F12) and cursor keys. Although reduced in size, the cursor keys are all there (not doubled up, as with the ActionNote), and the arrow keys have the inverted-*T* arrangement that most people prefer. Both Epson's and IBM's arrangements are necessarily compromised, but I find that the IBM arrangement slows me down less.

I also preferred the TrackPoint II, the ThinkPad's pink-rubber pointing device, over most trackballs, although a mouse is better still. The pink stick connects to a



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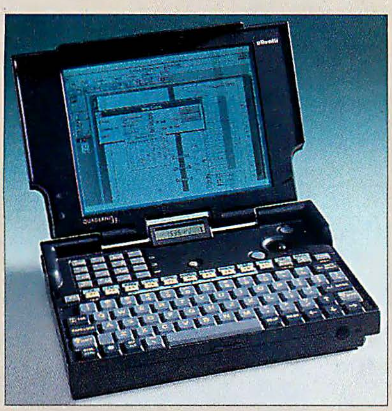
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Olivetti's Quaderno Now Does Windows



When BYTE last looked at the Olivetti Quaderno (see "Ultraportable PCs: Worth the Trade-Offs?," April BYTE), we found that it filled a niche somewhere between a bulky palmtop and an underpowered subnotebook. With an 8086-compatible V30 chip running at 16 MHz, 1 MB of RAM, a 20-MB hard drive, and a reflective LCD screen, the Quaderno could run DOS, but you couldn't touch-type on the diminutive keyboard.

Quaderno's attraction was its built-in voice-recording capability: a microphone, a speaker, and digital recording software. In addition to using the Quaderno as an electronic notebook with the supplied suite of business software, you could also use it as a dictation machine, pressing "tape recorder" buttons on the outside of the case (or function keys if the top is up).

Olivetti's updated Quaderno 33 has the same appealing voice-recording functions as the original, but it has moved into the Windows environment, thanks to a hardware boost that has bulked it up a pound in weight and almost half an inch in thickness. In addition to Windows 3.1, bundled software now includes Microsoft Works and Lotus Organizer.

With a 20-MHz AMD 386SXLV CPU, 4 MB of RAM (expandable to 12 MB), and an 80-MB hard drive, the Quaderno 33 is now just fast enough to run Windows. The screen has also gained backlighting. Besides adding weight, these hardware changes have decreased battery life. In a worst-case situation with power management disabled, the Quaderno 33 lasted only an hour and a half on battery power.

The price has gone up along with the weight. While the original Quaderno now sells for $699 (down from $1195), the Quaderno 33's price is up to $1750. The Quaderno has definitely moved into subnotebook territory, but you still can't touch-type on it.

pressure transducer that senses the amount and direction of pressure you apply. The device is no more accurate than a trackball for moving the cursor long distances across the screen, but you don't have to lift your finger from it (as you sometimes do for a trackball when you need to put in an extra roll), so it's less annoying when you have to make secondary adjustments. And for small movements in a local area, the TrackPoint gives finer control than even a mouse. It also lets you keep your fingers on the home row. The "mouse buttons" are within thumb reach on the front of the case.

The ThinkPad provides a plethora of power management options, all of which are readily available at any time with a well-marked function-key combination. Enabling doze mode allows the CPU to slow down when it's not busy (e.g., between keystrokes). Suspend shuts down most subsystems in the ThinkPad but leaves the contents of memory intact so that programs pick up where you left off. Hibernation is a state where memory contents are saved to disk and the computer shuts off totally.

You can also set timers for shutting down the hard drive, the display, or the whole system, and specify whether parallel and serial ports are power managed. The ThinkPad can be aroused from suspend mode by modem, or you can set a particular wake-up time.

The lead-acid battery has no memory effect, so you can top it off as much as you like without worrying about shortening battery life. The self-charging battery can be plugged directly into the wall for charging, eliminating the need for the included AC adapter if you can charge the battery when you're not using the system. With power management pushing battery life to over 4½ hours, that's a real possibility for some users.

The ThinkPad has a standard printer port, but the video port and the floppy drive/serial port have miniature nonstandard connectors. However, IBM provides two adapter cables that create the necessary standard connectors, as well as the floppy drive connection. The parallel port supports EPP (enhanced parallel port). The sliding door that covers the external ports on the right rear of the machine won't break off or fall out, but it sometimes gets off track when closing—a minor annoyance at most.

You can expand the ThinkPad's RAM to a maximum of 12 MB. Although there is no internal modem slot, the single Type II PCMCIA slot will do. The ThinkPad is PCMCIA 2.01 compliant; this new designation covers the latest PCMCIA hardware and Card and Socket Services standards. The ThinkPad also uses an Intel PCMCIA controller chip that most older card drivers support. The system comes without a case or Windows; on the other hand, it comes equipped with Prodigy software and IBM DOS 6.10.

The Performance Choice

The Epson and IBM notebooks are comparable in size, weight, and many other features. Epson's ActionNote 4000 costs at least $50 less for a comparable configuration and comes with a case and Windows.

Nevertheless, the IBM ThinkPad 500 clearly comes out ahead. It offers better performance, longer battery life, easily accessible and superior power management, and a workable keyboard layout. ■

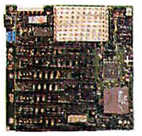
Dave Rowell, a technical editor for the BYTE Lab, has reviewed notebooks and other systems for 10 years. You can contact him on BIX as "drowell."

Company Information

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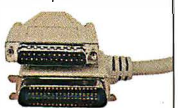
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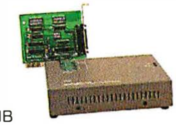
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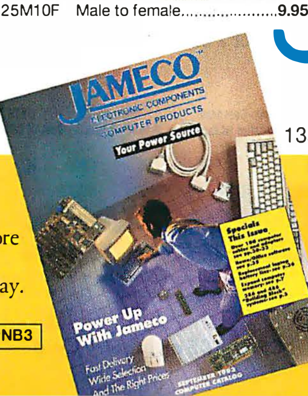
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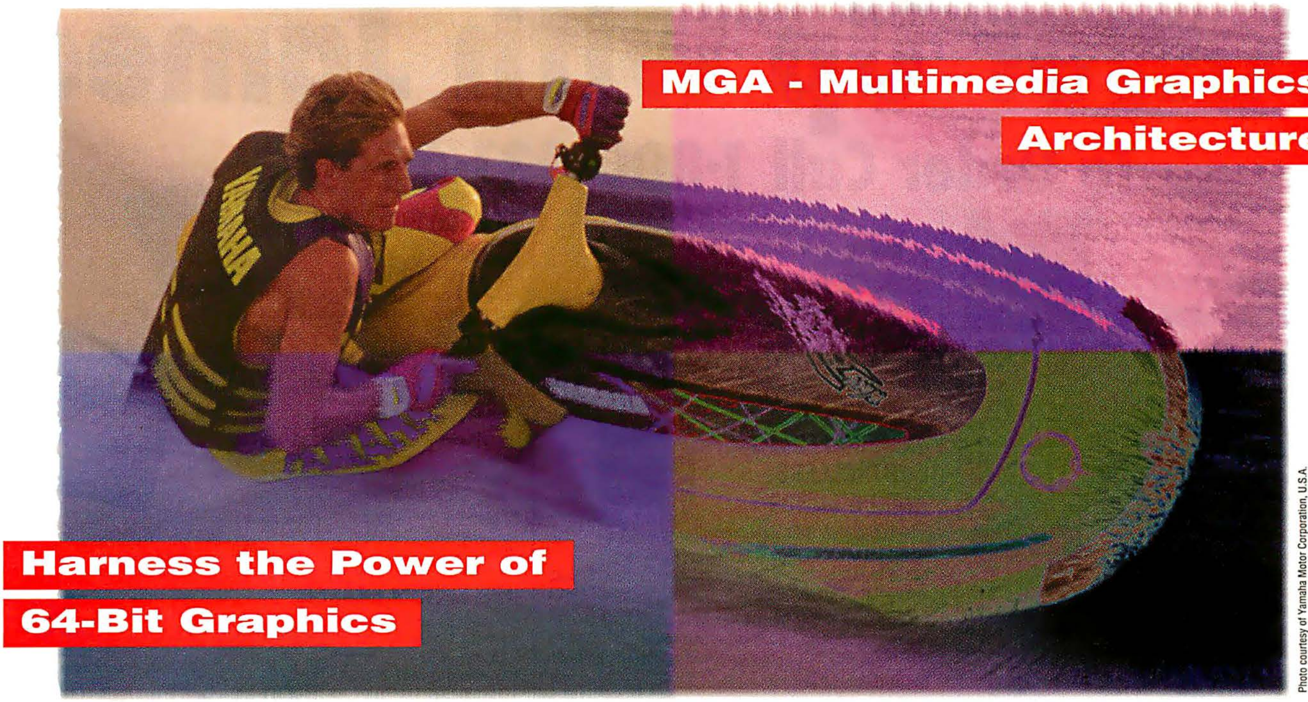


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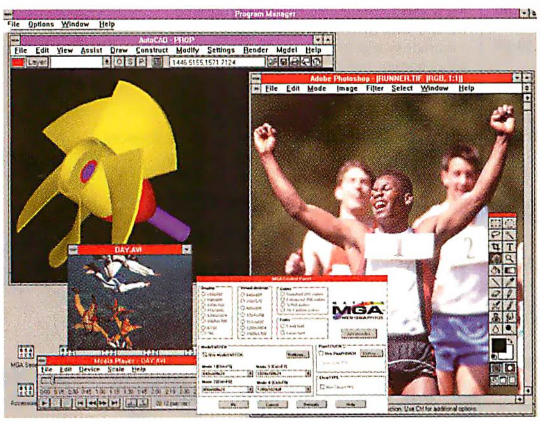




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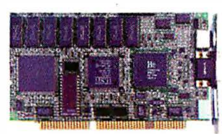
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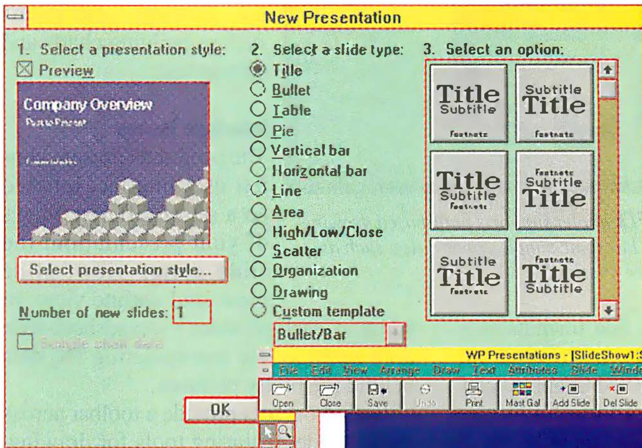
Harvard Graphics proves its mettle as the presentations market leader against an upstart challenge from WordPerfect Presentations

MARK CLARKSON

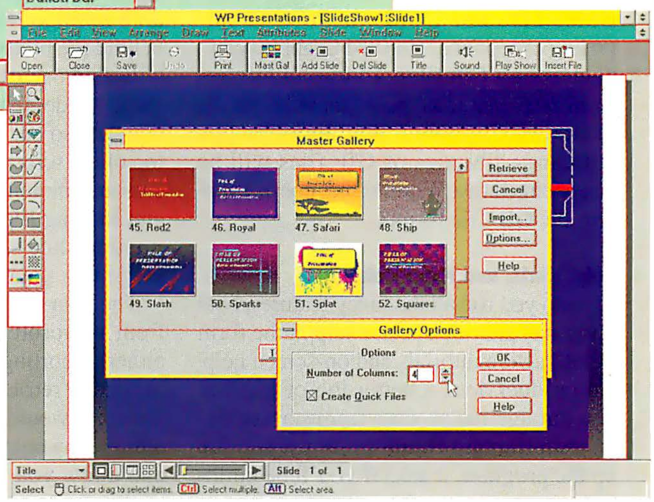
It's always exciting to witness a fray between an established veteran and a newcomer. Software Publishing Corp.'s Harvard Graphics is the granddaddy of the presentation graphics world. In fact, SPC takes unabashed credit for having created the whole field way back in 1986. SPC's latest entry is Harvard Graphics for Windows 2.0 ($395).

WordPerfect—best known for its popular word processor—is a newcomer to the presentations arena with its contender WordPerfect Presentations for Windows 2.0 ($495). (Don't let the version number fool you; there was no version 1.0).

I pit the two packages head-to-head to see how WordPerfect's entrant stands up against the standard set by Harvard Graphics. In many ways, WordPerfect Presentations holds its own, but some serious flaws hamper its appeal.



From Harvard *Graphics, you can select a presentation style, a slide type, and a template from a single Window. A thumbnail view lets you see how your slide selections will look on-screen.*



WordPerfect *Presentations' Master Gallery delivers a wide range of prebuilt slide styles to choose from. Presentations packs in the features but also exposes some first-version instability.*

Baroque Backgrounds

Multimedia is *the* buzzword for the 1990s, and these programs simply bristle with multimedia tools: sound, music, video, special effects, bit-map and vector graphics, charts, sophisticated drawing tools, and so on. And by the way, they can display text, too.

Frankly, if you're just doing bulleted word charts to slap onto an overhead projector, you don't need either of these programs, although they would make your task easier. In fact, most of the newer, snazzier features are geared specifically toward presentations given on a PC; if you're sending the output to slides or overhead transparencies, the multimedia features don't do you any good at all.

WordPerfect Presentations tries hard to be your one-stop graphics shop. To emphasize its support of the TWAIN scanner interface, WordPerfect is bundling Logitech's ScanMan 32, a hand-held grayscale scanner, until October 31. Presentations plays sound and music (WAV, MIDI, and CD) and supports video through OLE (it's an OLE server and client). The package comes with an impressive collection of goodies, including a handful of WAV files, 100 MIDI music files, 30 ATM fonts, 1000 pieces of clip art, and 60 backgrounds ranging from vanilla to Byzantine.

WordPerfect includes a bit-map image editor, but it's not much of an improvement over the paintbrush program that comes with Windows. It has no good variable-zoom feature: You are zoomed either all the way out or all the way in. And if you're all the way in, most of the tools don't work. I found it impossible to crop images that were too big to fit on the screen all at once.

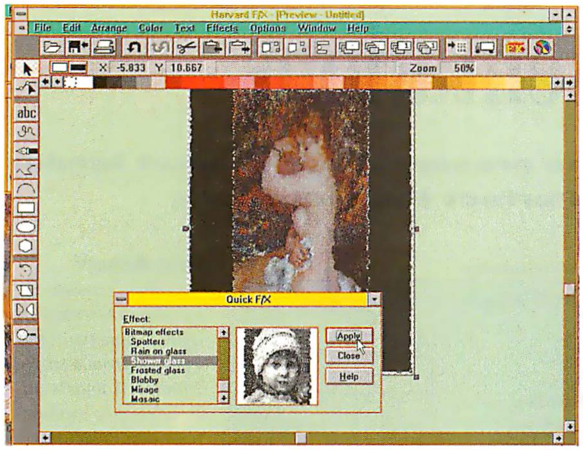
Harvard Graphics lacks TWAIN support and comes with a smaller but adequate collection of over 500 pieces of clip art. This package also integrates support for sound (MIDI, WAV, and CD) and video and supports OLE, both as a client and as a server.

Special Effects

Harvard Graphics comes with an applet (a mini-application), called F/X, for producing fancy drawings. F/X supports sophisticated path-based drawing and provides some special effects for bit maps, text, and objects. All of this is nice, but some simple capabilities (e.g., cropping or rescaling a bit map) are missing. I need to crop bit maps much more often than I need to render them as seen through frosted glass.

F/X feels like a bit of a kludge, something bolted onto the side of the product as an afterthought. I wanted to apply some of those cool text effects to my slides, but it's not that easy. In fact, you can't run the F/X program directly from Harvard Graphics; you must run it as a separate program from the program manager, or you can embed an F/X object in your presentation via OLE. On the other hand, since F/X is a stand-alone program, you can use OLE to embed F/X pictures in any OLE client—your word processor, for example. I expect to see F/X more fully integrated into the product in future versions.

Both of these programs read and write



The Harvard Graphics F/X *applet supports path-based drawing and special-effects filters, but some simple capabilities, such as cropping and rescaling, are missing.*

most popular graphics file formats (e.g., BMP, TIF, and CGM), with some surprising exceptions. Harvard Graphics can't read its own F/X files. To import pictures from F/X, you must paste them in via the Windows Clipboard. And those of you with large libraries of GIF files will be disappointed that WordPerfect doesn't support the GIF file format.

Help, Hints, and Hand-Holding

To help you use all the fancy features, both programs provide special help in the form of interactive tutorials and on-screen help. No product does a better job of guiding you through the process from start to finish than Harvard Graphics. When you fire up the program, it asks if you'll be building a new presentation or editing an existing one and offers you the chance to run the tutorial. (To my annoyance, Harvard Graphics' tutorial wouldn't run on my system in more than 256 colors.)

Version 2.0 sports an on-screen advisor—an extra window that provides tips, hints, and help relevant to your current slide. It reminds you, for example, that your title page should have few words and use mixed uppercase and lowercase letters for improved readability. It also tells you how to perform common editing chores, such as changing fonts and selecting screen colors. Once you've mastered the program, you'll probably want to turn the advisor off and recover the screen space it occupies. But if you're new to Harvard Graphics or presentations in general, it provides welcome support.

WordPerfect doesn't mother you the way Harvard Graphics does. When you start up the program, it drops you right into an empty presentation. I don't know why it should be any more annoying than being placed in a blank document in your word processor, but it is.

WordPerfect's analogue to Harvard Graphics' Advisor is Quick Cards, a collection of help screens that you can open up to guide you through operations such as building charts and editing text.

Interface Issues

The programs present similar user interfaces, based on a set of different views of your presentation: the slide sorter view, slide view, and outline view. In addition, each provides a spreadsheet-style data manager for manipulating the data behind the pretty pictures.

Both programs provide a toolbar across the left side, featuring tools for drawing, text, and so on, and an icon bar across the top of the screen, providing one-touch access to common operations, such as saving and loading files, arranging objects, and running slide shows. The programs will also check your spelling.

The data managers let you import data from Microsoft Excel or Lotus 1-2-3 files, either importing an entire spreadsheet all at once or retrieving a named region of it. This task would be much easier if the data managers would show you the source data and allow you to select the portion you wish to import. Instead, you must remember the name or the range, or you must import the whole spreadsheet and then trim it down.

I'm not happy with the defaults either program offers for a number of different graphs, especially those where the data is all of the same magnitude (say, 20 numbers all between 13 and 14). The default lines are much too thick and detract from the slide's readability. Fortunately, the look of the graphs is easy to change in both programs. Harvard Graphics provides a thumbnail picture of your graph so you can see the effects of your changes, while WordPerfect provides a split-screen view with the actual chart in the bottom.

When I last looked at Harvard Graphics (see "Presentations to Go," BYTE's *Essential Guide to Windows*, Spring 1993), it scored high for ease of use, and now SPC has made it even easier. Harvard Graphics has added a toolbar full of icons across the top of the screen for easy, one-button access to common functions. If you're unsure just what any of the icons on the toolbar do, run the mouse cursor across them; the title line across the top of the screen gives you a brief description of the buttons' functions.

Harvard Graphics is not without its annoying quirks. For example, initially, tool selections don't stick. After every operation, the tool reverts to a pointer. Hence, if you want to draw five boxes, you have to select the box tool five times. Luckily, a hard-to-find checkbox (under Default Options) fixes this.

Harvard Graphics' button bar can be customized, although not as easily as WordPerfect's bar. And Harvard Graphics for Windows includes a deinstall program to remove the application and all its accompanying files from your hard disk. Anyone who's ever sorted through the clutter of the Windows directory, trying to remember which files belong to applications that aren't even on the system anymore, will appreciate this.

The new version of Harvard Graphics also includes conferencing capability. Only one person (designated the conference leader) can advance the slide show or use on-screen chalk to highlight points in the presentation, but up to 64 viewers can access the presentation by simply logging onto the same network server as the conference leader and loading the file. The conference leader can pass control to any other conferee, who can then run the slide show and use the on-screen chalk. Audio is not supported, but you can set up a conference call so that the conferees can listen to the presentation as the slide show appears on each computer screen.

Harvard Graphics also incorporates a messaging system, so conferees can send electronic messages to each other as a presentation is delivered. No additional hardware (other than a network setup) is required.

Less Than Perfect

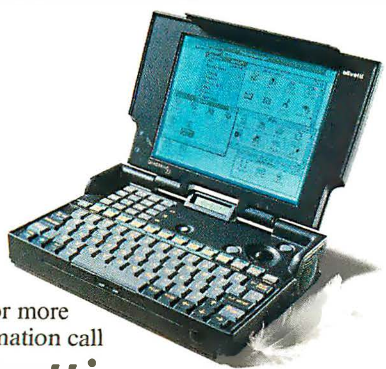
I especially appreciated WordPerfect's file manager. It allows you to do all those things you would like to do from a directory listing—such as move, copy, and delete files—but usually can't. WordPerfect's button bar is fully and easily customizable: You can select any item on any menu and drag that command onto the button bar.

I like the layout of the controls in the left toolbar. It's easy to toggle between filled and unfilled objects and, similarly, to select and deselect outlining. The pop-up menu on the bottom makes it simple to

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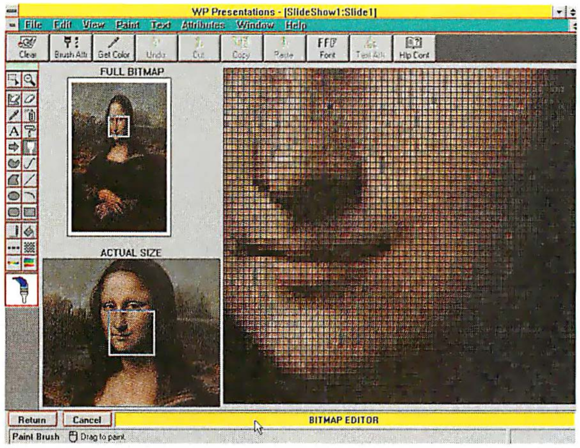
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Reviews Point-and-Click Presentations



WordPerfect Presentations *comes bundled with a bit-map editor, but it's not much of an improvement over Windows Paintbrush.*

change slide types (e.g., from a title slide to an organization chart).

To edit any object on the screen, just double-click and you are taken to the chart editor program. Type in your changes and click on return. This makes sense if you're editing a large block of numeric data, but it's a *slow* way to edit simple text. A title change takes almost twice as long under WordPerfect as it does in Harvard Graphics, where you edit text directly on the slide.

The chart editor allows you to do some powerful editing. You can easily skew the chart around in three dimensions, looking at your data from above or below, right or left.

But WordPerfect Presentations has some serious problems. Often when I closed down a series of menus, I found little bits of flotsam lurking on the screen—fragments of menus and dialog boxes that were incompletely erased or, occasionally, too completely erased, leaving blank holes on the page. These artifacts weren't part of the slide—any operation that forced WordPerfect to redraw the screen took care of them—but they were pretty annoying.

The bit-map editor would also blow up when called on to edit relatively large bit maps (e.g., 640 by 480 pixels). And worst of all, WordPerfect had a habit of "eating" pieces of my slides. Three times during the review, elements disappeared from slides in my presentations. I had saved the work, but the elements were missing from the saved files as well. The files seemed fine, and not all slides were affected.

WordPerfect's technical support was unable to tell me what was causing the problem, unable to duplicate it, and, as far as I know, unable to find anything wrong with the files in which it had occurred. One customer-support representative admitted that it had happened to him once, although no one had ever been able to figure out exactly why it happened.

Needless to say, if you've spent the entire morning laboriously constructing a complicated slide for a presentation to your boss, you do not want to find that most or all of the elements in one of your slides have simply gone away. This is a serious problem.

And the Winner Is...

As a long-time user of WordPerfect, I wanted to like WordPerfect Presentations. WordPerfect packs in lots of features and more clip art, more music, more frills, and more gewgaws. It's got a bit-map editor and its own supply of fancy new fonts.

But the program just isn't solid. WordPerfect Presentations is full of little oversights, and it crashed on both of my machines many times, providing a variety of errors from general protection faults to a mysterious divide-by-zero error. Harvard Graphics, on the other hand, was solid as a rock. Even the beta version never crashed, never hung, and never, *never*, lost my data.

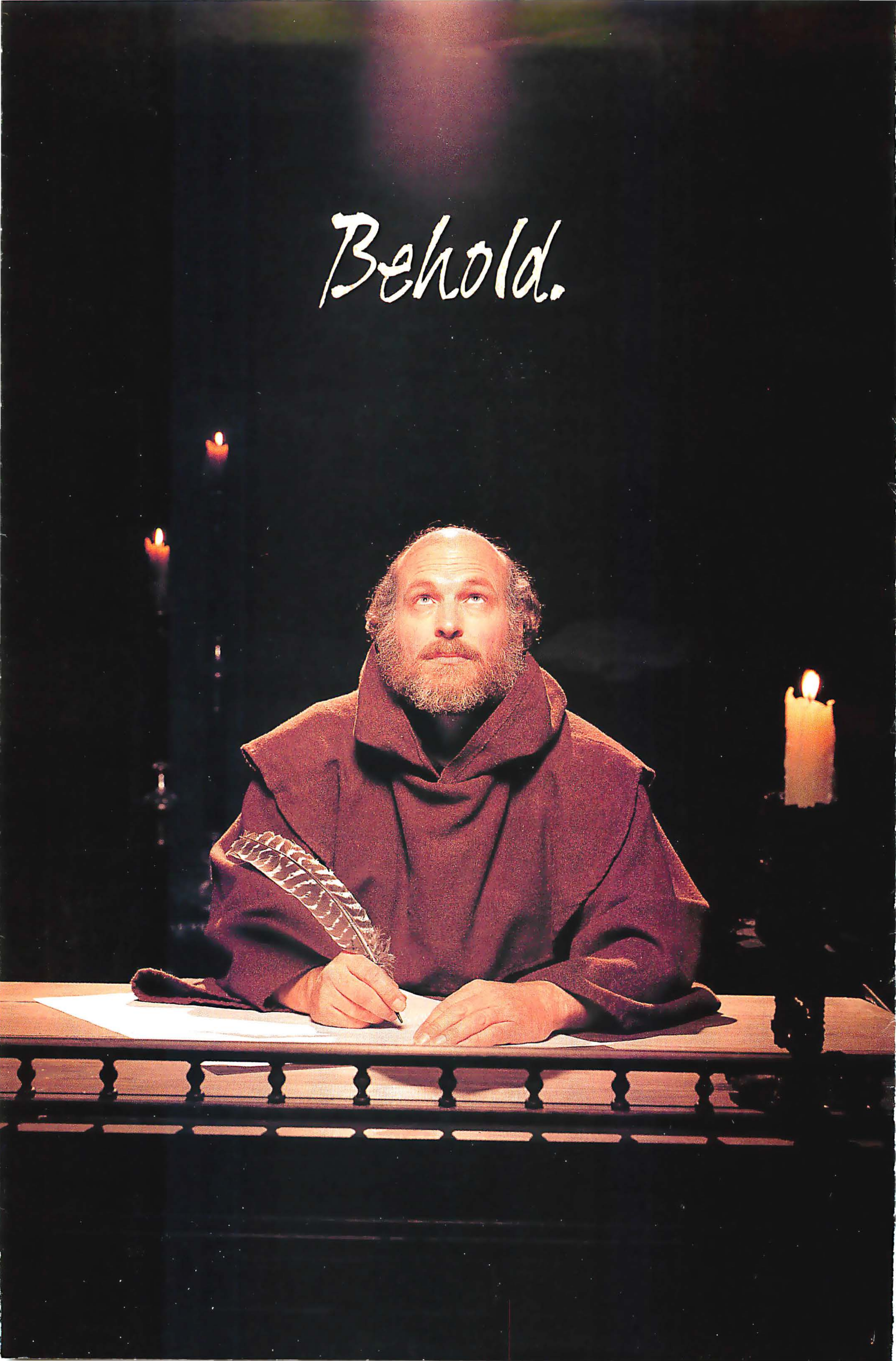
If WordPerfect can clean up this program, the company will have a legitimate challenge to SPC, Lotus, Microsoft, and the other leaders in the presentation graphics field. For now, however, WordPerfect Presentations does not live up to its promise. Harvard Graphics is still the champ. ■

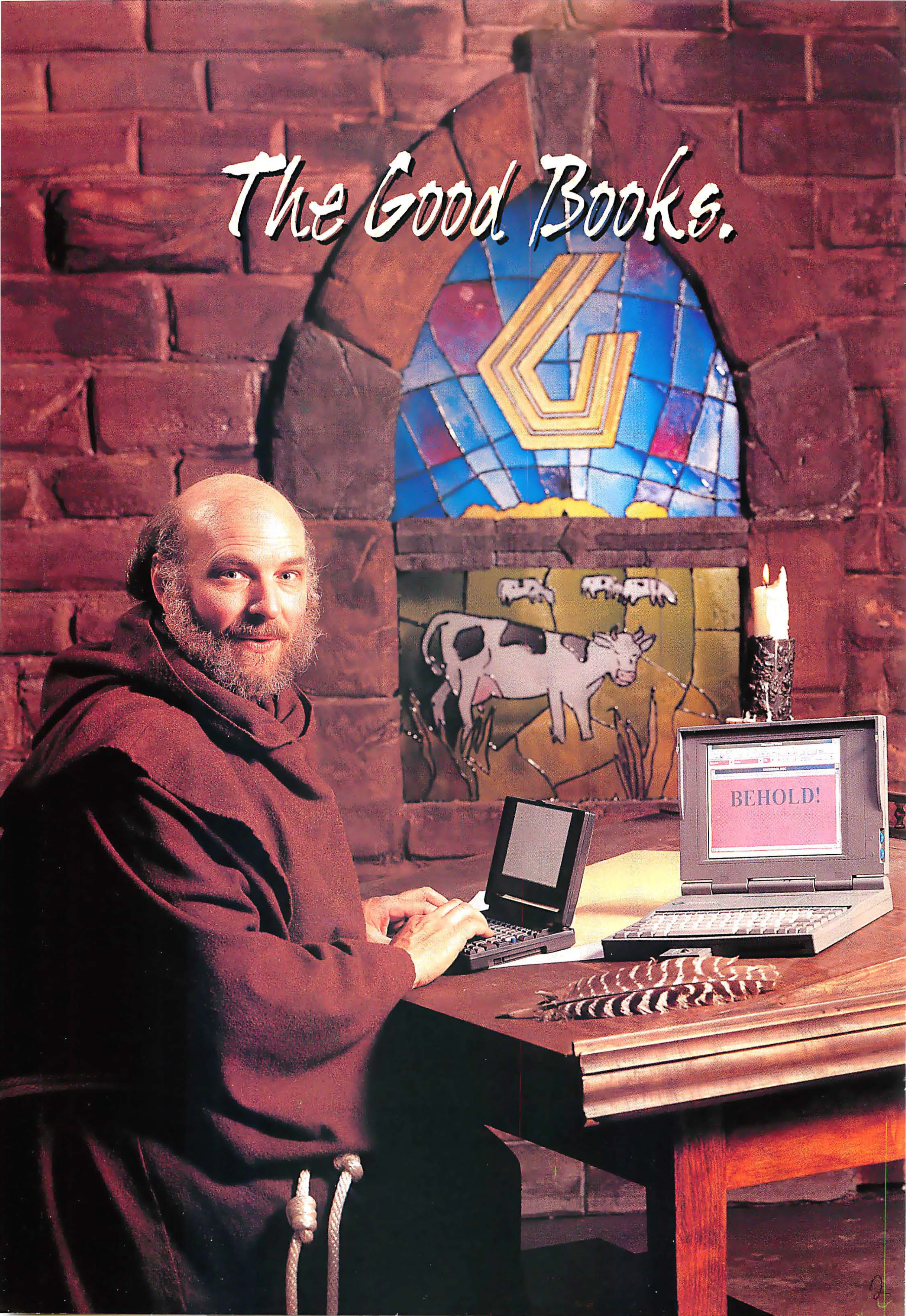
Mark Clarkson (Wichita, Kansas) is a BYTE consulting editor and a freelance writer. He reviewed presentation software for BYTE's Essential Guide to Windows *(Spring 1993). You can contact him on BIX as "mclarkson."*

About the Products

Harvard Graphics for Windows 2.0 .... $395
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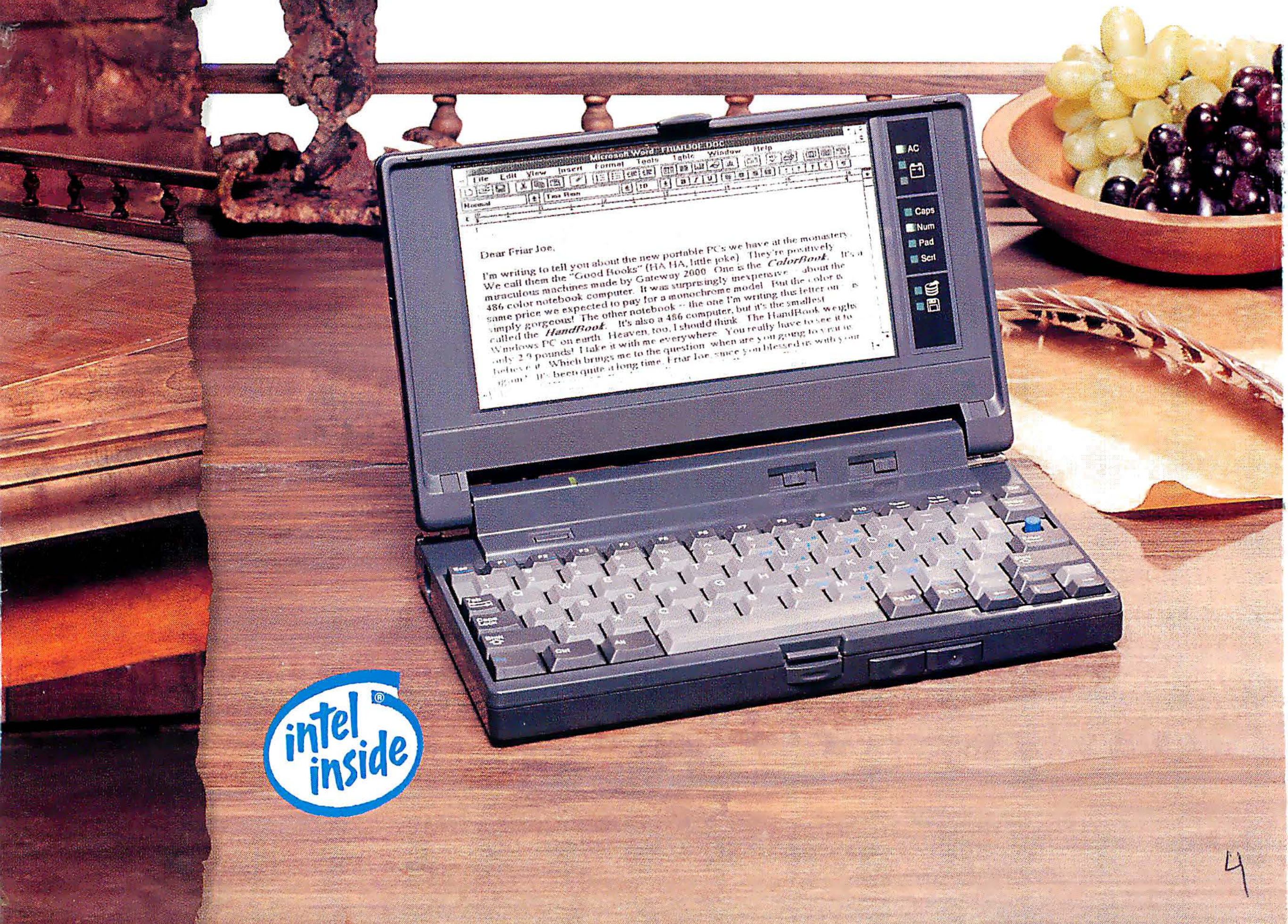
The HandBook 486 includes an 80MB or 130MB hard drive for today's larger Windows programs and files. With the Interlink software utility and serial download cable provided, you can easily transfer data between the HandBook and other PCs.

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The ColorBook

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- NiMH Battery & AC Pack
- Suspend/Resume Feature
- 2 PCMCIA Type II (or 1 Type III) Slots
- Integrated Track Ball (2 Buttons)
- 85-Key Keyboard
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COLORBOOK 486SX-33

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- Dimensions: 11.7" x 8.5" x 1.77"
- 33MHz SL Enhanced Intel 486SX CPU
- 4MB RAM (expandable to 20MB)
- 3.5" 1.44MB Diskette Drive
- Removable 170MB IDE Hard Drive
- 9.4" VGA Dual-Scan STN Color Display
- NiMH Battery & AC Pack
- Suspend/Resume Feature
- 2 PCMCIA Type II (or 1 Type III) Slots
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- 3.5" 1.44MB Diskette Drive
- Removable 170MB IDE Hard Drive
- 9.4" VGA Dual-Scan STN Color Display
- NiMH Battery & AC Pack
- Suspend/Resume Feature
- 2 PCMCIA Type II (or 1 Type III) Slots
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- Suspend/Resume Feature
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- Integrated Pointing Device
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COLORBOOK COMBOS

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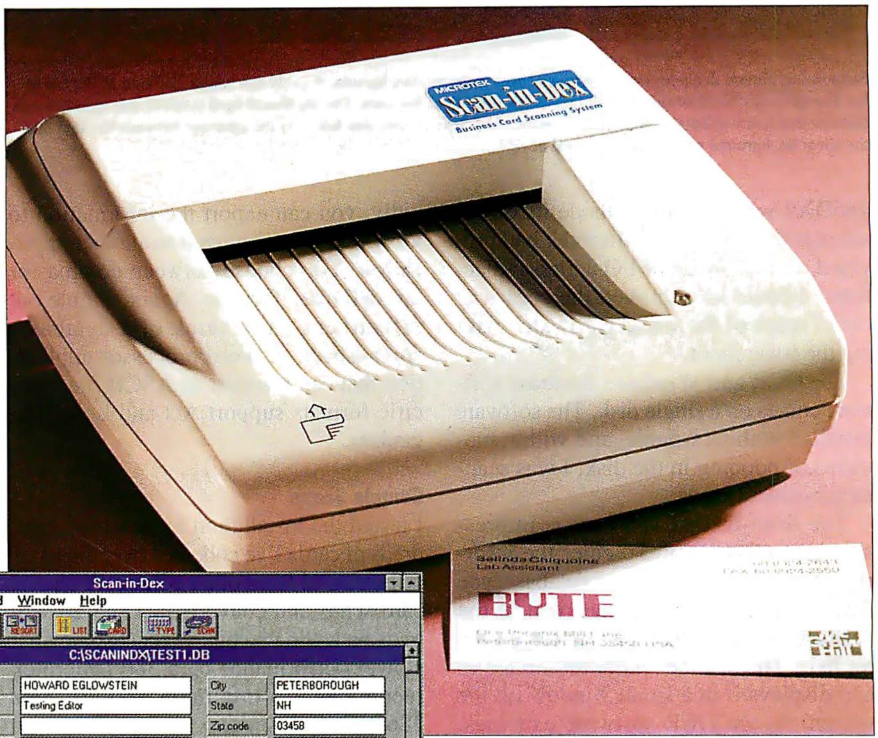
The Business-Card Shuffle

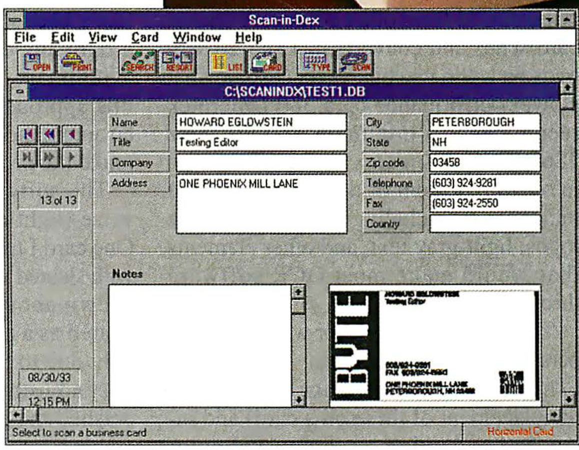
The Microtek Scan-in-Dex scans business cards and puts them where you can find them—in a searchable Windows database

HOWARD EGLOWSTEIN

If you collect a lot of business cards and need to keep track of the contacts, you know the problem: Either you can sift through the cards every time you need a phone number, or you can manually key the information into a database every time you get a card. Microtek's Scan-in-Dex promises to deal you a fresh hand by scanning your cards, recognizing the names and addresses, and storing the information in a searchable database. It's an idea that's been floating around the industry for a long time, but no one has been able to implement it until now.

The $399 Scan-in-Dex package is a combination of hardware and software for your 386 or better PC running Windows 3.1. The scanner is a svelte unit, weighing in at just over 1½ pounds and taking up just 6½ by 6 inches on your desk. An 8-foot cable attaches the scanner to the 8-bit interface card that slides into a free slot in your PC. The scanner gets its power from the interface card. The software installs easily and provides a simple but minimalist user interface to a lightweight database application.





Scan-in-Dex scans business-card data into a searchable Windows database. Intelligent algorithms automatically drop the information into the appropriate fields. In this case, the software could not handle the company name because of its vertical orientation on the business card.

A Tough Hand

Scanning business cards and applying OCR technology isn't a new idea. Several packages have let you place your business cards on a flatbed scanner, extract the information, and store it in a database. But most of these packages haven't worked well, due to the limitations of standard scanner and OCR products. A 300-dpi scanner teamed with OCR software is usually straining to get reasonable accuracy with 6-point text.

Most mainstream OCR software is designed to read business documents (typically printed at 10 or 12 points), printed in standard "business-like" fonts. Business cards often feature text in many colors, include some tiny text items (perhaps as small as 4-point), and use unusual fonts in creative ways to make a statement. Elements like these present a significant challenge to OCR vendors and require specially adapted OCR algorithms. Microtek's OCR software (licensed from Ocron) was designed to handle the various characters typically used on business cards, and automatic gray-scale thresholding helps differentiate colored text on colored backgrounds.

If you've tried arranging a handful of business cards neatly on a copier's glass, you've experienced the other big problem: getting the information into the computer so that the OCR software can get a look at it. Microtek's solution is elegant: The scanner is built specifically to scan business cards. It's a single-feed 400-dpi scanner, optimized for pulling a variety of business-card stocks through its mechanism. There's no power switch, and no buttons of any kind. To scan a business card, you simply place the card in the input tray.

A Diamond in the Rough

Getting my evaluation unit working took some doing. First, I tried installing the scanner interface into a typical machine for the times: a 66-MHz 486DX2 with 16 MB of memory, a CD-ROM, and a sound card. Microtek provides jumper settings for four different I/O selections, but the scanner just didn't want to run in this machine.

I then moved the card to a different PC: a 33-MHz 486 with a similar configuration but with components from different vendors. After I made sure I moved the interface card's I/O address to step around the sound card, the interface card installed fine. It could be that the sound card in the



Scan-in-Dex cannot decipher many business cards with creative layouts. It could not handle the logo at the top of the Stargate card (left) or the reverse text at the bottom of the card. The DigiBoard card (center) was doubly tough because the text was both slanted and reversed. And Scan-in-Dex was foiled by the contrast between the text and the silver background of the business card at right.

486DX2 was stepping outside its designated address range. If Microtek had provided a wider range of I/O address selections, I could have moved the card way out of reach of the sound hardware, making the issue moot.

The OCR and Windows database software comes on a single disk. The software installed without trouble, and within moments of popping in the disk, I was scanning business cards.

The Scan-in-Dex software is impressive in its simplicity. To enter the information from a card into your database, you simply drop the card face-down in the scanner and click the Scan button on the toolbar. The scanner pulls the image in and displays it in a small window on the screen. As the OCR software executes, you see the status in the business-card window. Within seconds, the name, address, phone numbers, and other information from the card appear in the proper fields on the database entry screen.

To figure out what information goes into which field, Scan-in-Dex uses clues from the data format. It keeps a small database of titles and positions. When it finds keywords such as *president* or *manager* in a line, it knows that it has found a title. Phone numbers are usually in the format *(xxx) xxx-xxxx* or something similar, and fax numbers are often preceded by *fax:* or *telefax:*. Any information that the OCR software recognizes but can't place goes into a general Notes field. You can then drag and drop data from place to place on the database form.

If the card won't fit into the scanner's 3.6- by 2.4-inch maximum limit, you simply enter the card data manually. However the data gets there, you can sort it by name or company, and display it onscreen or print it on any Windows-compatible printer. Finally, you can export the information to an ASCII file to move it to another application. You choose between comma- or tab-delimited formats. Again, simple but effective: I can't think of a database, spreadsheet, or word processor application that can't import an ASCII file. Specific formats support Act and Lotus Organizer.

Sample Scans

I tested the installation by scanning hundreds of cards I've collected over the years or borrowed from other editors. A typical card scans and converts in 15 to 20 seconds on a 486 machine; expect somewhat slower performance on a 386 (Microtek recommends a minimum of a 20-MHz 386DX). Scan-in-Dex successfully read in over 50 percent of these cards without major errors, including some very strange logos, light-gray text, and other elements that would make most OCR software throw in its cards.

The most common error was confusing personal names and company names (there is no accurate heuristic for determining the placement of these on a card) and incorrectly adapting to an unusual color scheme. The scanner's automatic contrast adjustment could usually pick up light-gray text on a white background. However, if there was a nearby logo or element in black, the scanner got confused and failed to find the gray text. Still, I don't think I've ever seen any standard office OCR software that could do any better.

Microtek's intended audience is the busy professional who wants a quick and easy solution for entering information from business cards. The trade-off for simplicity and ease of use is leaving out some features.

The most glaring omission is the unconfigurable database-field layout. You get fields for name, address, company, title, country, one phone number, and one fax number. Some people have multiple phone numbers or E-mail addresses; this information just gets lumped into the Notes field.

The OCR Challenge

Many of the test cards I ran through the scanner contained colored text, strange fonts, and graphical elements. The Ocron OCR software did a remarkable job of picking letters out of many of the logos, and it seldom failed to decipher the tiny 4-point text that a lot of these cards had.

To handle horizontal and vertical formats, you have to tell the software which way the card is oriented before scanning it. This proved to be annoying as I shoveled cards through the scanner for the better part of an hour, but I suspect that I'd find it less of a problem if I only had one or two cards at a time.

I would have liked to see the software handle this situation using a technique common throughout the OCR industry: If you scan a card and the entire thing looks like gibberish, go through the data again at a right angle and try recognizing it then. With images as small as a business card, this approach can't be hard, and having an automatic card-orientation mode would make the product easier to use.

The software also will not handle reverse (light on dark) text or slanted text. One card I tried was dark green and black, with slanted white text (the DigiBoard card shown above). The scanned image appeared as a mangled checkerboard (probably due to the scanner's automatic contrast adjustment), and the OCR software crashed the application with an unrecoverable error. That problem would not have bothered me—after all, the manual specifically states that the software won't do reverse or slanted text—but I hadn't saved the results of over a half-hour of scanning cards. The whole database was lost.

Scan-in-Dex isn't perfect, and it's not going to scan every business card. Microtek has a few loose ends to deal with: The box won't connect to your laptop computer yet, and having to tell the software the card format should be unnecessary. But in spite of its faults, Microtek's Scan-in-Dex is an elegant solution to a difficult problem. ■

About the Product

Scan-in-Dex $399
(including 8-bit interface card and scanner)

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680 Knox St.
Torrance, CA 90502
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fax: (310) 538-1193
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Howard Eglowstein is a testing editor for the BYTE Lab. You can contact him on BIX as "heglowstein."



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Your software protection strategy shouldn't be a hit or miss proposition. But with so many conflicting claims about one vendor's product being better than another, we can understand why you might want to leave it to chance.

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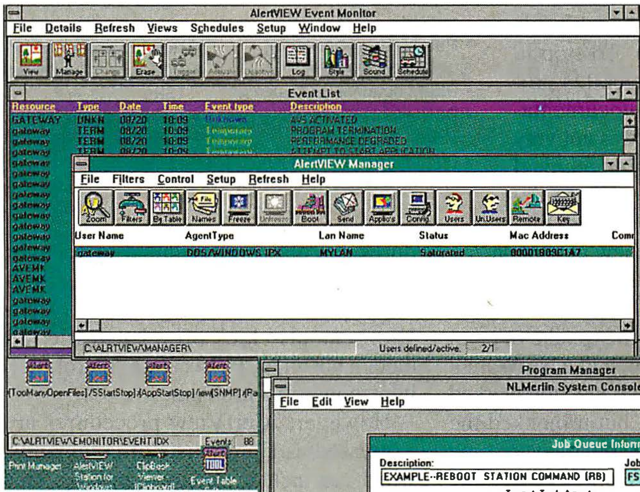
NLMerlin and AlertView

A pair of watchdogs for PC-based LANs monitor network problems and take action

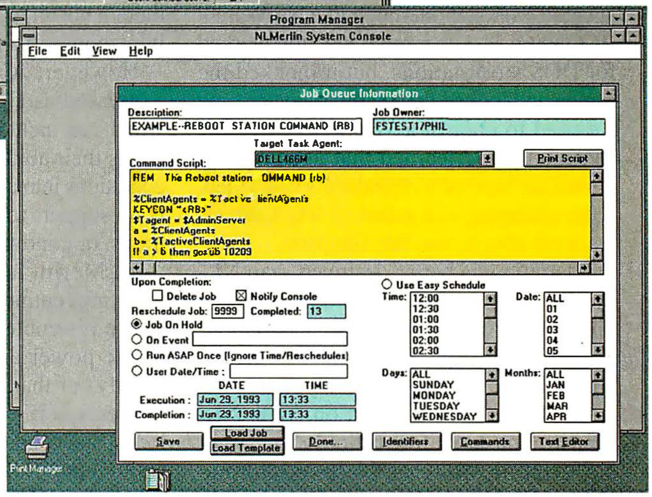
MIKE HURWICZ AND DAN CARROLL

Network management usually boils down to fire fighting and handling routine tasks. Unlike most PC management utilities, Knozall's NLMerlin and Shany's AlertView are management tools that can help automate both ends of the job.

Although these products address similar gaps in the network management market, they are more complementary than competitive. AlertView's strength is monitoring and responding to problems in Windows and DOS applications. This package also detects network-related problems encountered in these applications. NLMerlin focuses on NetWare file servers and is better suited to day-to-day task automation than to handling problems. NLMerlin also offers some task automation and problem handling for DOS and Windows workstations.



AlertView's *management console, which consists of the AlertView Manager and the Event Monitor. AlertView is centered around a Windows-based control module, with agents for monitoring DOS and Windows events residing on other workstations.*



NLMerlin's *Job Queue Information screen, showing the beginning of a sample script for rebooting a workstation. NLMerlin is NetWare-centric, with the central automation module implemented as an NLM, but you can program NLMerlin through this Windows interface.*

What They Do

NLMerlin consists of four types of modules: administrative server agents implemented as NLMs (NetWare loadable modules), NLM-based server task agents, workstation task agents implemented as TSR programs, and a Windows-based administrative utility or *system console.* Only one server has to have an administrative server agent. When present, the administrative server agent is combined with a server task agent in a single NLM.

The system console, communicating with the administrative server agent by way of a direct file interface, is used for managing security and scheduling jobs. Once a job is in the queue, the administrative server agent keeps track of it and distributes it to one or more task agents. Task agents on either servers or workstations receive and carry out jobs. The administrative server agent communicates with task agents via IPX, using MCPs (Merlin control packets).

AlertView is also an agent-and-manager combination. The two functions are performed by a Windows-based administrative utility (the management console) and workstation agents implemented as TSRs. The management console is used to monitor events, schedule and initiate procedures, and gain control of workstations through the workstation agents. The agents monitor system events and report them to the management console. All modules communicate via IPX, DLC (data-link control), NetBIOS, or TCP/IP and proprietary packets.

A more detailed look at the information gathered by the two programs highlights their differences. AlertView detects and records application activities, including starting and stopping applications, file operations (e.g., open, close, access denied, and file not found), interactions with peripherals (e.g., drive not ready and serial port time-out), Windows errors (low Windows system resources), and network client errors (e.g., network device driver error, sharing violation, locking violation, send/receive error, network busy, and IPX/SPX time-out). NLMerlin can't detect a single one of these application events.

On the other hand, NLMerlin can determine the number of server volumes, current server utilization, average server utilization over the last 10 minutes, number of connections on the server, total disk space, and percentage of disk space in use on a server, as well as information specific to the NetWare bindery (e.g., the number of user, group, and server objects in the bindery). On its own, AlertView will only display the name of the primary server. (Through integration with the NMS [NetWare Management System], AlertView can get and respond to SNMP alerts, including alerts from Novell's server-based agents. But when it comes to managing servers, NMS can do as well without AlertView.)

Running Each

Installation is straightforward for both products, though a little faster for NLMerlin (with only one disk to install) than for AlertView (which has six). We had some problems learning to use AlertView. For

ALERTVIEW 2.1	NLMERLIN
• Works on any network supporting Windows workstations • Doesn't monitor server information • Starts and stops DOS and Windows applications remotely • Has Windows-based command module • Offers optional OS/2 agents • DOS agents implemented as TSRs • Control program through graphical Windows program	• Works with NetWare only • Provides detailed NetWare server monitoring • Can't gather specific Windows information from workstation agents • Loads and unloads NLMs automatically • Has NLM command module • DOS agents implemented as TSRs • Provides control automation through BASIC-like scripts

instance, we had trouble starting applications on remote Windows workstations. We could start Windows accessories like Notepad or Clock, but not other applications. In addition, we were unable to stop the Windows accessories. Eventually, we learned that we had to enter the full path of the executable file to start the application. To stop it, we simply had to reselect this program from a list. The documentation for these functions was not very clear, and even Shany's technical support required three calls to determine the problem. We were told that these functions are new in version 2.1.

We also had trouble using AlertView's remote function, which allows the management console machine to take over an agented workstation, much like NetWare's RCONSOLE. The remote function worked for DOS workstations, but it blanked the screen and locked the keyboard every time we tried to control a Windows machine. Eventually, we learned that agented machines are limited to standard VGA video. After changing to a standard VGA driver, we were able to use this function.

AlertView is better designed than NLMerlin for detecting and handling errors. First of all, AlertView is designed to monitor all application operations and errors. By selecting from a pick list, you can tell it which ones not to report on. With NLMerlin, you have to explicitly query, in the script file, for each piece of information. AlertView displays the probable cause (in addition to a description of the event, the user name, and the workstation address) and suggests a solution.

The network manager can configure AlertView to respond automatically with predefined corrective procedures for a set of problems. With NLMerlin, in contrast, the manager has to determine appropriate corrective procedures and write them into a script. NLMerlin offers no suggestions. In addition, NLMerlin lacks built-in support for editing files such as CONFIG.SYS or AUTOEXEC.BAT; this would be useful when correcting errors.

In a typical corrective procedure, AlertView might modify the AUTOEXEC.BAT file, notify the user that his or her workstation will be down, reboot the machine so that modifications will take effect, restart the application that the user was in, and, finally, notify the user that the problem has been corrected. Various common procedures are included; they may be used as is, modified, or used as examples. Procedures can also be scheduled to occur at specified times on specific dates or periodically, such as a nightly backup. AlertView can also kick off a batch file (although not an NCF [NetWare control file]) in response to a problem.

However, AlertView procedures are expressed as simple lists of commands, which can include keystroke macros. This limits their ability to take varying system conditions into account. For example, there is no support for IF ... THEN logic, FOR loops, or conditional subroutines.

NLMerlin is better designed for automating routine procedures. Its script language resembles BASIC, offering some of the power and flexibility (and complexity) of that language, including such elements as IF ... THEN logic, FOR ... TO loops, and conditional GOSUB and GOTO statements. Such capabilities are indispensable for handling the vagaries of real environments when complex tasks execute automatically. Lists of commands and keystroke macros don't offer much leeway for variation.

The Long Run

Both programs—but especially NLMerlin—leave us with some concerns about long-term and enterprise-wide strategy. Software and hardware vendors interested in NLMerlin's automation will have to explicitly support NLMerlin. Knozall doesn't appear to have the market clout to attract third-party developers. Furthermore, APIs and interfaces to distributed task management functions may eventually be standardized, perhaps under the auspices of the DMTF (Desktop Management Task Force), a group now boasting more than 200 vendor members, including Hewlett-Packard, IBM, Intel, Microsoft, Novell, and SunConnect. If no committee standard emerges, de facto standards are likely.

Contrast NLMerlin with Hermes, Microsoft's proposed centralized desktop management system. Hermes will run under Windows NT and will offer functions such as hardware and software inventory, software distribution and installation, remote diagnostics, and remote control. Hermes's software distribution function will actually distribute jobs, with or without accompanying data. While the initial intent is to do such things as copying a new printer driver to drive C or running the setup program for a new piece of software, there is no inherent limit to the jobs that could be shipped around the network.

How Hermes will define jobs is not yet clear. However, given Microsoft's dominance of the desktop software environment, that definition could become a de facto standard. Hermes will also support committee standards. To gather information about network nodes, for instance, Hermes will use MIFFs (management information format files), which are ASCII files in a format defined by the DMTF. The API for registering managed objects and interfacing to MIFFs will be the DMTF's DMI (Desktop Management Interface).

NLMerlin can perform many of the functions promised from Hermes. However, since NLMerlin is not based on any management standards, it will be harder to get third-party support.

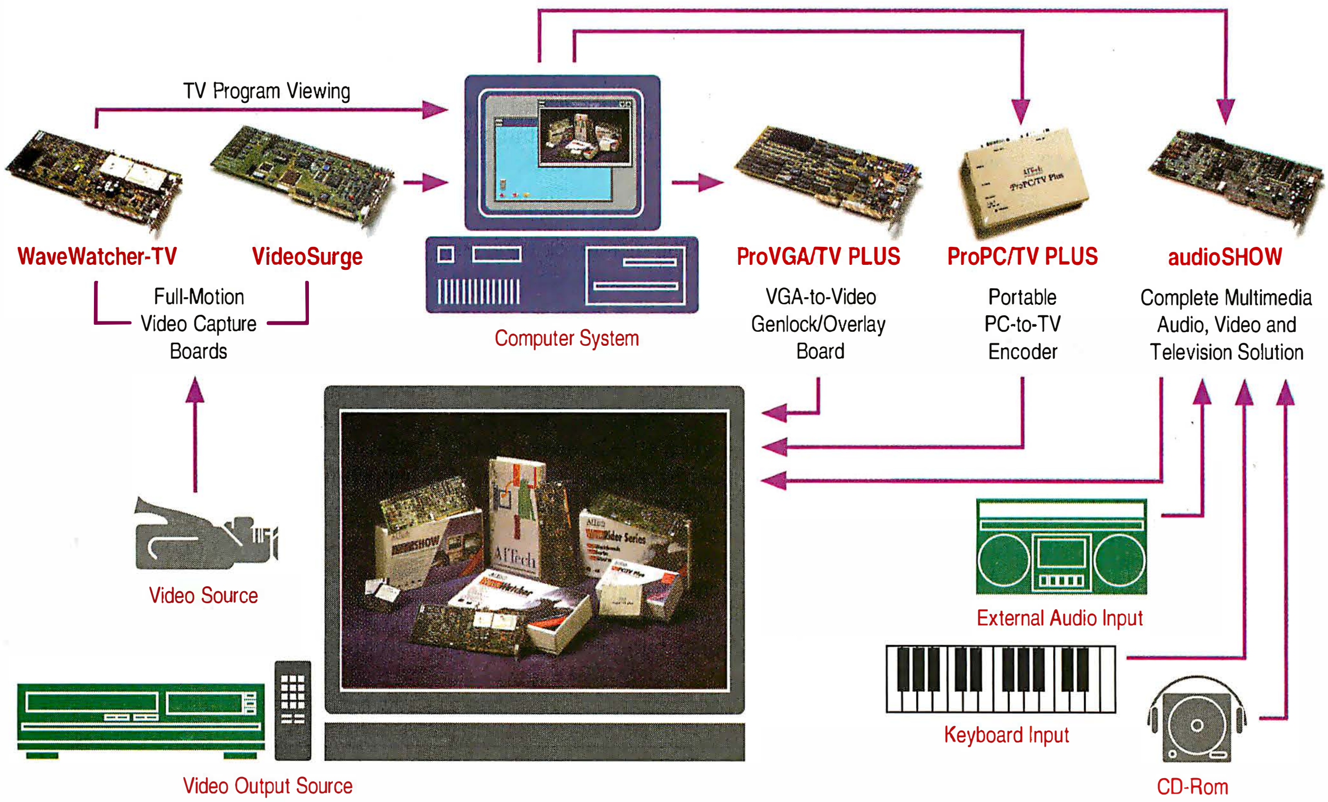
It may still be possible for Knozall to support DMTF or other standards. Knozall says it will respond to the needs of the market by interfacing to standards as they develop, and that it anticipates no major problems in accommodating whatever standards emerge. Meanwhile, NLMerlin is here now. The same can't be said of products like Hermes. NLMerlin's scripting language closely resembles BASIC, thus making use of a well-established standard. In making a decision about NLMerlin, you should weigh immediate needs for task distribution against potential advantages of waiting for standards in this arena.

We also would have liked to see the ability to generate and receive SNMP alerts in NLMerlin. This would have made it easier to integrate NLMerlin's functions into corporate networks and ensured some level of integration with existing management applications.

Shany provides SNMP integration for AlertView through integration with the NMS. This integration enables NMS to

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discover AlertView agents and put them on an NMS map with an icon that accesses AlertView's tools. AlertView and NMS can also receive, display, and respond to each other's alarms. Thus, NMS can receive SNMP traps and forward them to AlertView, or receive AlertView's alarms and forward them as SNMP traps.

In addition to providing this support for SNMP, AlertView is based on well-defined, stable Windows application APIs. Thus, AlertView already works with all Windows applications. It would still help if AlertView took advantage of DMTF standards where possible; if it doesn't, it may not be able to obtain some critical information.

Interestingly, Windows NT includes an event monitor that provides error-related information and suggestions similar to those provided by AlertView. We like the idea of monitoring applications through an operating-system utility as opposed to a third-party package. If Microsoft ever decides to offer a Windows event monitor and then hooks it into a central console such as Hermes, Shany could have some serious competition.

The difference between NLMerlin and AlertView in terms of a strategic direction boils down to this: Task distribution is in its infancy; anybody who invests now may have to backtrack when standards and standardized products emerge. In contrast, standards for monitoring applications are already firm. Because it focuses on application monitoring more than on task distribution, AlertView is less vulnerable to outflanking by a new standard.

Overall, we see value in both of these products. AlertView is more accessible and is easier and more fun to use. It adds significantly to your ability to manage Windows and DOS applications but not NetWare servers. NLMerlin is good at managing servers, is currently less capable in the workstation arena, and lacks the ability to monitor applications.

Both products seem to have lots of room for expansion and may serve as a basis for future capabilities. Still, NLMerlin will remain a tool for the type of user who would write DOS batch files and program in BASIC using just a text editor—in other words, a tech-weenie—while AlertView will appeal to the average network administrator who wants to know what is happening in users' applications. ■

About the Product

NLMerlin $2195
(includes one Windows-based administrative agent, two NetWare file-server agents, and 20 DOS client agents)

Knozall Systems, Inc.
375 East Elliot Road, Suite 10
Chandler, AZ 85225
(800) 333-8698
(602) 545-0006
fax: (602) 545-0008
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AlertView 2.1 .... $935
(includes one Windows-based management server and 10 DOS/Windows client agents)

Shany, Inc.
1101 San Antonia Rd.
Mountain View, CA 94043
(415) 694-7410
fax: (415) 694-4728
Circle 1076 on Inquiry Card.

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176 PRINTERS FACE OFF

From high-end dye-sublimation to low-cost dot-matrix models, we select the best printers for eight important business applications

HELEN HOLZBAUR, JIM HURD, AND STEPHEN PLATT

New printers continue to hit the market at breakneck speed: Of the 176 printers tested here, 70 of them either didn't exist when we prepared our last printer report in May or have been significantly upgraded since then. What's more, five of the eight printers that received BYTE Best awards in this report only began shipping since this spring.

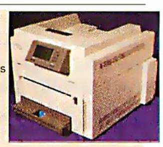
For printer buyers, a dynamic market is good news. Prices in the last six months have dropped dramatically: The 105 printers that remain on the market since our May report now cost an average of $500 less. The bottom line for those who need a new printer is that cutting-edge performance and print quality have never been less expensive.

Through hands-on tests of laser, dot-matrix, ink-jet, high-end color, and portable printers, this report documents the advances of the printer market. We invited vendors to submit printers for every category. Besides our memory specifications, which were necessary to make our test results comparable, our only restric-

How to use this guide

In each application category, we name a best overall printer that offers the best mix of performance and quality plus any required features relevant to the particular application. We also name the best low-cost printers for each application, as well as highest quality and best for use with Macintosh environments.

BEST OVERALL **Lexmark IBM 4039Laser 12R**



Competitively priced with slower printers, this 12-ppm laser really screams when you install Lexmark's software-rasterizing Windows drivers. Overall, its 600-dpi quality is among the best in its class. Unfortunately, its PostScript performance is lackluster. For heavy PostScript usage, pick the TI MicroLaser Pro 600 Turbo with the PowerStep accelerator board instead.

Each score represents pages-per-minute speed; higher numbers indicate faster performance.

A composite score of text and graphics output; based on a scale of 10, with higher numbers indicating better output quality.

			BYTE PERFORMANCE SCORES (PPM)							
			PC PCL	PC POSTSCRIPT	MAC OVERALL	QUALITY INDEX	CLASS (PPM)	PRICE	RESOLUTION (DPI)	MEMORY(MB) STAN., MAX.
BEST	LexmarkIBM4039Laser12R	▲	8.63'	3.57	5.04	8.74	12	$1999	600	4,16
RUNNER-UP	LexmarkIBM4039Laser10R	▲	7.04'	3.12	4.32	9.00	10	$1599	600	2,16
RUNNER-UP	TIMicroLaserPro600 (w/PowerStep)	▲	3.98	5.37	5.23	8.72	8	$1948	600	6,22
RUNNER-UP	XanteAccel-a-Writer8000	▲	5.18	2.67	2.78	8.44	8	$2295	600	8,16
RUNNER-UP	HP LaserJet 4M	▲	4.85	3.21	3.95	8.78	8	$2399	600	6,32

Vendor's rating for engine or print-head speed; does not include printer processor time.

Retail price; may include optional memory to conform to our testing specifications (see "How We Tested").

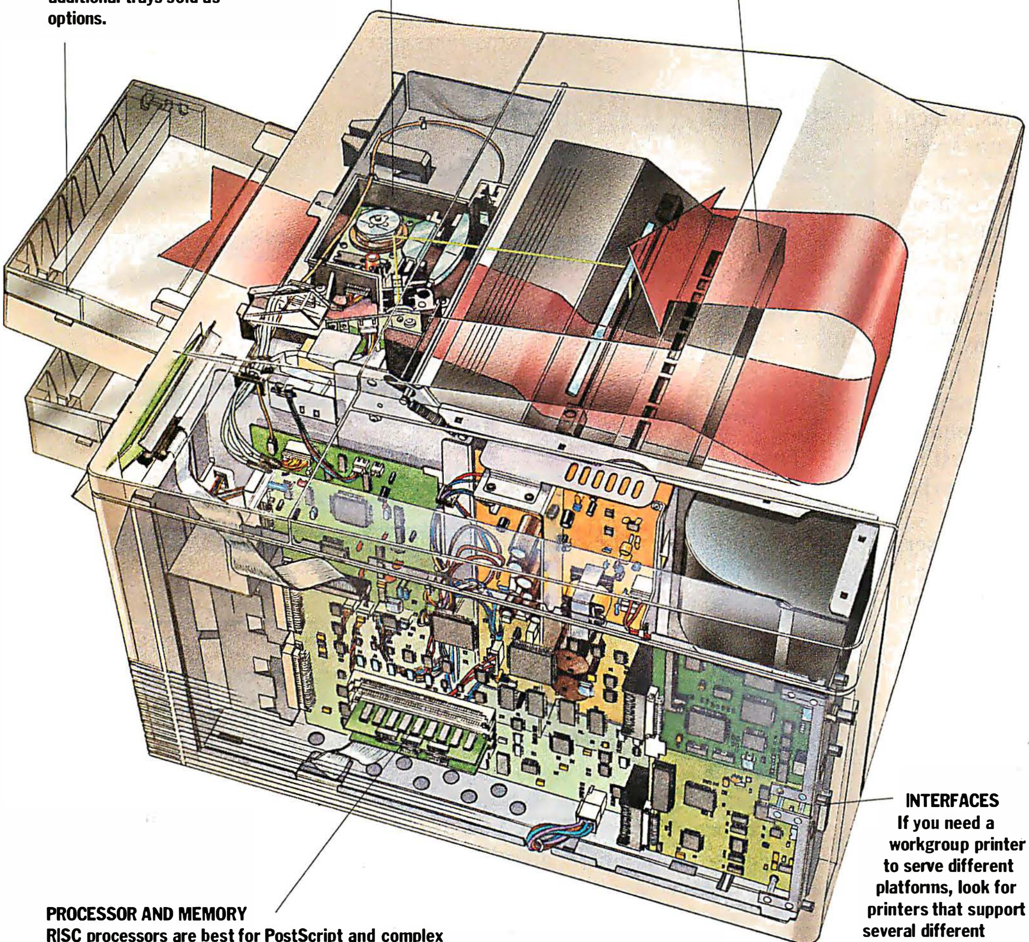
PHOTOGRAPHY: STEVE BELKOWITZ ● 1993

What to Look For in a Laser Printer

PAPER-INPUT TRAY
Network printers typically hold 500 to 1000 sheets. For workgroup and word processing applications with high volumes, consider printers with larger trays or additional trays sold as options.

ENGINE
Choose a 600-dpi engine for high output quality; for lower printer cost and faster performance, a 300-dpi engine is a better alternative.

PAPER PATH
The shorter the path, the more efficient the printing process and the less chance for jammed paper. For envelope and heavy-stock printing, choose printers that provide a straight-through path.



PROCESSOR AND MEMORY
RISC processors are best for PostScript and complex graphics. One MB of memory is minimum for full-page graphics; 4 MB is minimum for PostScript.

INTERFACES
If you need a workgroup printer to serve different platforms, look for printers that support several different interfaces and can automatically sense which interface is receiving a print job.

tions were price related: We didn't test any network or color printers costing over $15,000, and all other models carried list prices of $10,000 or less.

Lasers continue to make inroads into the low-cost market. A dozen in this report carry list prices of approximately $1000. In response to this competition, ink-jet printers now sell for $200 to $300 after discounting. At this price point, ink-jets have entered the price domain of dot-matrix printers. What's more, new high-speed ink-jets, like the C-Tech Speedjet 300 and Texas Instruments MicroMarc, now run as fast as dot-matrix printers, which are increasingly becoming niche products for multipart forms and invoices.

Color printers are at the cutting edge of development. Eighteen of the new printers we tested were color printers, and many had impressively low prices. From the $319 LA 95-DECWriter to the Tektronix Phaser IISDX, a $10,000 dye-sublimation printer, color output has never been better or offered at so many price points.

In this report, we've divided the printers into eight categories to make it easier for you to match a printer to your needs. For PC and Mac users, we selected printers for general business, draft text, high-quality color, general-purpose color, workgroups, tabloid, CAD and desktop publishing, and travel.

NOVEMBER 1993 BYTE BEST PRINTERS **BEST**

GENERAL BUSINESS
Lexmark IBM 4039Laser 12R
Posted the fastest times for PC text and graphics, along with respectable PostScript and Mac scores. **PAGE 279**

HIGH-QUALITY COLOR
General Parametrics Spectra Star GT
This $5000 thermal-wax-transfer printer uses standard paper and produces brilliant color images. **PAGE 285**

GENERAL-PURPOSE COLOR
Hewlett-Packard DeskJet 1200C/PS
The best ink-jet output for both color and monochrome text. **PAGE 289**

WORKGROUPS
Hewlett-Packard LaserJet 4SiMx
Superb quality and the fastest performance overall. **PAGE 291**

DRAFT QUALITY
C-Tech Speedjet 300
An ink-jet printer that outpaced even some lasers for speed in producing reports and forms. **PAGE 293**

LARGE FORMAT
Mannesmann Tally MT 360
The choice among dot-matrix printers for 11- by 17-inch print jobs. **PAGE 295**

CAD AND DTP
Compaq PageMarq 20
The fastest laser able to handle 11- by 17-inch paper. **PAGE 299**

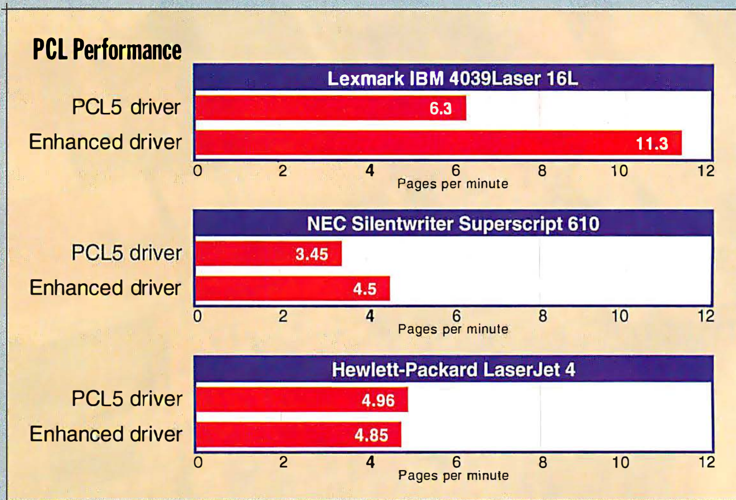
PORTABLE
Lexmark IBM 4070 IJ
A 4-pound ink-jet with the fastest print speed among portables. **PAGE 301**

ILLUSTRATION: BRUCE SANDERS© 1993

THE BEST PRINTERS FOR GENERAL BUSINESS

High-quality output makes laser printers the standard for business documents, which may range from correspondence, to proposals and reports, to standard-format desktop publishing (see the CAD and desktop publishing section for large-format laser printers). The printers we rank in this section are suitable for use by up to five people. Because of quality considerations, we considered only laser printers for this category. The lasers ranked here are rated at 12 pages per minute or less; to be considered for best in the low-cost category, a laser had to be rated at 6 ppm or less.

ENHANCED DRIVERS



Printer performance, in pages per minute.

Within the past year, both IBM and NEC have introduced "enhanced" PCL5 languages on their printers. These languages, supersets of HP's PCL5 printer language, provide additional features for improved graphics and font-rendering performance. The languages are true supersets—the printer will still operate using a normal PCL5 driver, but using the accompanying drivers will improve their performance.

We tested the Lexmark IBM 4039Laser 16L and the NEC Silentwriter Superscript 610 using both PCL5 and enhanced drivers and compared them to a Hewlett-Packard LaserJet 4 running the driver that ships with the printer and a standard PCL5 driver. While using IBM's 4039-16L print accelerator, the 4039Laser 16L was 44 percent faster in our benchmark tests. Using straight PCL5, it averaged 6.3 ppm on our test suite, but when driven by the IBM 4039-16L print accelerator it averaged 11.3 ppm. Likewise, the NEC Superscript 610, using NEC's Superscript 610 GDI (Graphical Device Interface) language, improved from 3.45 ppm to 4.5 ppm, a 24 percent decrease in print time. The LaserJet 4's driver speeds up font and bit-map processing, but overall it lags behind the PCL5 version because of slower text and graphics performance.

Although 300-dot-per-inch laser printers are appropriate for most business applications, low-priced 600-dpi laser printers such as the Lexmark IBM 4039Laser 10R ($1599) led us to recommend the high-resolution models unless you're on an especially tight budget. If so, low-cost 300-dpi printers such as the NEC Silentwriter Superscript 610 ($700) and the Hewlett-Packard LaserJet 4ML ($1279) are excellent choices.

However, if you're printing newsletters with graphics or doing any type of desktop publishing, a 600-dpi laser printer is the only way to go. Among the higher-resolution lasers, we call it a draw for overall quality among HP's LaserJet 4M, the Lexmark IBM 4039Laser series, the TI MicroLaser Pro 600, and the Apple LaserWriter Pro 630.

Brother's HL 10H also produced top-quality 600-dpi output; unfortunately, its gray-scale dithering fell short of that of the other leaders. HP's LaserJet 4 and 4P also fell down a bit on gray-scale reproduction.

The Xante Accel-a-Writer 8000 and 4000 and Samsung Finale Hi-Res all use resolution enhancement to coax higher resolution from print engines designed for 300-dpi output. In general, the quality of the Xante printers is on a par with that of the 600-dpi printers, although its text does not have the same clarity at small point sizes. Resolution enhancement is less successful with the Finale, however. Samsung claims the printer can simulate 1200 dpi, but its output quality in our tests did not even approach that of a true 1200-dpi printer. (The printer is also designed to be upgraded to a true 600-dpi resolution, but we didn't test this feature.)

The fastest printers for Windows were the ones designed to accept rasterized pages from the host computer. The Lexmark IBM 4039Laser 12R and 10R printers and the NEC Silentwriter Superscript 610 use this technique to outperform conventional PCL (Printer Control Language) and PostScript drivers shipped with Windows. Because this technique is heavily dependent on the host, the faster your computer, the faster these printers will print. (We obtained our speed scores using a 33-MHz 486DX with 8 MB of memory.)

All the 4039-series printers offer a wide range of features,

including power management, optional duplexing, an easy-to-read five-line LCD showing configurations, and flash ROM to store fonts and logos.

For graphical illustrations and desktop publishing, or for use with a Macintosh, choose the TI MicroLaser Pro 600 equipped with the optional PowerStep accelerator board ($349). This 8-ppm unit blasts through PostScript jobs faster than many 16- and 17-ppm printers. The printer's quality is comparable to that of 600-dpi printers. Unlike the PhoenixPage PostScript interpreter in the Lexmark printers, the Adobe interpreter in the MicroLaser supports Level II. However, the MicroLaser's PCL performance is below average for an 8-ppm printer, so don't purchase this printer if you primarily print PCL jobs.

For low-cost PostScript, we recommend the HP LaserJet 4ML. At $1279, it is not the cheapest printer you can buy, but its high quality and good performance make it worth the incremental cost. Its RISC processor puts it among the fastest of the 4-ppm printers; it even outperforms many 8-ppm printers. Of all the laser printers, the LaserJet 4L and 4ML are among the biggest power savers: They consume just 5 W when idle. With its "L" series, Hewlett-Packard has introduced draft mode to the laser world: The print quality is reduced, but so is toner consumption.

If you want the best combination of low cost and high performance for non-PostScript jobs, pick the NEC Silentwriter Superscript 610. The quality was only average for a 300-dpi printer, however. Thanks to resolution enhancement, both the Epson ActionLaser 1500 and the LaserJet 4L offer higher-quality text and graphics than the Silentwriter Superscript 610, but they can't match its speed.

KEY

▲ Laser ■ Ink-jet
● Dot-matrix ◆ Dye-sublimation
★ Thermal

BYTE BEST — GENERAL BUSINESS

Need the best balance of speed and quality?

BEST OVERALL — Lexmark IBM 4039Laser 12R



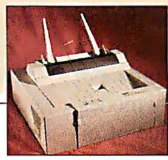
NOVEMBER 1993 BYTE BEST GENERAL BUSINESS PRINTER

Competitively priced with slower printers, this 12-ppm laser really screams when you install Lexmark's software-rasterizing Windows drivers. Overall, its 600-dpi quality is among the best in its class. Unfortunately, its PostScript performance is lackluster. For heavy PostScript usage, pick the TI MicroLaser Pro 600 with the PowerStep accelerator board instead.

			BYTE PERFORMANCE SCORES (PPM) PC		MAC	QUALITY	CLASS		RESOLUTION	MEMORY (MB)
			PCL	POSTSCRIPT	OVERALL	INDEX	(PPM)	PRICE	(DPI)	STAN., MAX.
BEST	Lexmark IBM 4039Laser 12R	▲	8.63[1]	3.57	5.04	8.74	12	$1999	600	4, 16
RUNNER-UP	Lexmark IBM 4039Laser 10R	▲	7.04[1]	3.12	4.32	9.00	10	$1599	600	2, 16
RUNNER-UP	TI MicroLaser Pro 600 (w/PowerStep)	▲	3.98	5.37	5.23	8.72	8	$1948	600	6, 22
RUNNER-UP	Xante Accel-a-Writer 8000	▲	5.18	2.67	2.78	8.44	8	$2295	600	8, 16
RUNNER-UP	HP LaserJet 4M	▲	4.85	3.21	3.95	8.78	8	$2399	600	6, 32

When price matters...

LOW COST — NEC Silentwriter Superscript 610



Thanks to a special Windows driver, this printer's Windows performance is stunning, as is its under-$700 price. A bidirectional Windows interface gives you excellent feedback on print status and settings without your having to look at the printer.

			BYTE PERFORMANCE SCORES (PPM) PC		MAC	QUALITY	CLASS		RESOLUTION	MEMORY (MB)
			PCL	POSTSCRIPT	OVERALL	INDEX	(PPM)	PRICE	(DPI)	STAN., MAX.
BEST	NEC Silentwriter Superscript 610	▲	4.55[1]	—	—	6.67	6	$700	300	0.25, [2]
RUNNER-UP	Brother HL 6	▲	3.84	—	—	6.67	6	$895	300	0.5, 4.5
RUNNER-UP	Epson ActionLaser 1000	▲	4.51	—	—	5.11	6	$799	300	0.5, 6.5
RUNNER-UP	Okidata OL-400E	▲	3.46	—	—	6.44	4	$699	300	0.5, 4.5

Is Mac support a must?

MACINTOSH — TI MicroLaser Pro 600 (with PowerStep)



This printer combines high print quality with the fastest Mac and PostScript performance, especially its font-rendering speed.

			BYTE PERFORMANCE SCORES (PPM) PC		MAC	QUALITY	CLASS		RESOLUTION	MEMORY (MB)
			PCL	POSTSCRIPT	OVERALL	INDEX	(PPM)	PRICE	(DPI)	STAN., MAX.
BEST	TI MicroLaser Pro (w/PowerStep)	▲	3.98	5.37	5.23	8.72	8	$1948	600	6, 22
RUNNER-UP	Lexmark IBM 4039Laser 12R	▲	8.63[1]	3.57	5.04	8.74	12	$1999	600	4, 16
RUNNER-UP	Apple LaserWriter Pro 630	▲	3.17	2.88	3.80	9.11	8	$2529	600	8, 32
RUNNER-UP	HP LaserJet 4M	▲	4.85	3.21	3.95	8.78	8	$2399	600	6, 32
RUNNER-UP	TI MicroLaser Pro 600	▲	—	2.66	3.83	8.72	8	$1599	600	6, 22

When print quality is everything...

HIGH QUALITY — TI MicroLaser Pro 600 (with PowerStep)



Although the MicroLaser Pro 600 didn't have the best quality when compared to other 600-dpi printer heavyweights (e.g., the LaserJet 4M, the Lexmark IBM 4039Laser series, and the Apple LaserWriter Pro 630), none of the others matched the MicroLaser for PostScript speed.

			BYTE PERFORMANCE SCORES (PPM) PC		MAC	QUALITY	CLASS		RESOLUTION	MEMORY (MB)
			PCL	POSTSCRIPT	OVERALL	INDEX	(PPM)	PRICE	(DPI)	STAN., MAX.
BEST	TI MicroLaser Pro (w/PowerStep)	▲	3.98	5.37	5.23	8.72	8	$1948	600	6, 22
RUNNER-UP	Apple LaserWriter Pro 630	▲	3.17	2.88	3.80	9.11	8	$2529	600	8, 32
RUNNER-UP	Lexmark IBM 4039Laser 10R	▲	7.04[1]	3.12	4.32	9.00	10	$1599	600	2, 16

[1] Score obtained with proprietary driver.
[2] Uses computer memory for jobs requiring more memory.

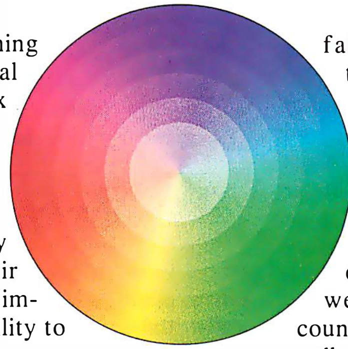
How We Tested

We subjected each printer to as many as 50 different performance and output-quality tests using DOS, Windows, and Mac applications. As appropriate, we tested each printer in letter-quality and draft modes; with PostScript and PCL page-description languages; and using LocalTalk, parallel, and Ethernet connections.

Not every printer is right for every application, so we segmented printers into eight business applications. See the individual application write-ups for details about filters we chose for grouping technologies. For example, with workgroup printers, we considered only those laser printers that were rated at 15 ppm or higher.

We identified the best printers for Mac users by considering only printers that provided a LocalTalk or EtherTalk connection. You can use other printers with a Mac by using products such as Apple's DOS Companion. In fact, the Apple Portable StyleWriter is identical to the Canon BJ-10ex except that the Apple model comes bundled with a serial-to-parallel converter and Mac drivers. Overall, we think most Mac users will do better by selecting printers designed to support the Mac environment.

Our performance scores are measured in pages per minute. We generated a performance index for each printer by weighing and combining scores of the individual tests (see the text box "Our Speed Tests") as appropriate for each particular application category. For example, we judged high-quality color printers by their ability to print color images, not for their ability to print text.


Color Wheel

CATEGORIES

In deciding our best-overall recommendations, we valued performance and quality equally. To determine performance scores, we averaged each printer's speed, measured in pages per minute, in draft and high-quality modes. When a printer offered a choice of either PostScript or PCL for high-quality modes, we used the scores from the mode that produced the fastest results.

We also evaluated each printer for the features it offered and for how easy it was to set up and use the unit. The scores served as filters: We did not recommend products that were difficult to use or lacked essential features, regardless of their speed and quality. For example, the NewGen ImagerPlus 12 has excellent performance and quality, but it failed to run two of our tests. Workgroup printers that do not support automatic switching between PCL and PostScript did not receive "best" honors.

When choosing printers for highest quality, we made quality scores count for 80 percent of the overall evaluation, with the remaining 20 percent consisting of the printer's high-quality-mode speed. We noted that PostScript produced noticeably better output overall than PCL, so we used PostScript performance as a tiebreaker among printers that had very similar output quality.

For best low cost, we used price and technology filters to identify those printers that are likely to sell in the lower end of the price spectrum. For example, 4- to 6-ppm, 300-dpi printers dominate the low-cost laser market, and we considered only this class for our low-cost choices in the business category.

The winner of the low-cost category may not be the lowest-priced printer on a particular day through some particular channel; we cannot reliably predict how street prices might change from minute to minute. What our low-cost pick identifies is a printer that stands out from its peers by offering excellent value at a reasonable price. If a runner-up becomes available to you at a substantially lower cost, you can use the performance and quality measurements to make your own decisions.

OUR SPEED TESTS

We measured each printer's performance using a variety of tests designed to mirror real-world applications. To run our tests, we used Windows and Mac drivers supplied by the printer vendor. Our performance scores revealed how fast each printer could produce the following:

Standard Text
This test consisted of a word processing document in one font. We sent the test to the printer using the Windows or Mac drivers. If a printer had a device font available, we used it.

Raw Text
The same word processing document as above, but we sent it directly to the printer, not through the Windows driver.

Graphics
This consisted of a line-intensive world map with filled areas taken from CorelDraw clip art.

Color Graphics
This test consisted of balloon clip art from CorelDraw.

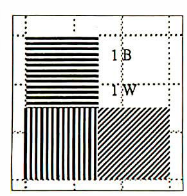
Bit Map
A test page of rasterized text, essentially the same as fax output. This generated scores applicable to graphics applications. It also showed the speed of the communications link between printer and computer.

Fonts
This document was rich in fonts in a variety of type sizes. The test uses serif and sans-serif typefaces in regular and boldface at 30 different point sizes.

Forms
This document consisted of a simulation of preprinted forms.

PRINT QUALITY

The quality tests measured each printer's ability to draw a variety of lines, reproduce a photographic image, and print attractive, legible text in a wide range of point sizes. We also had the color printers output a page that tested the printer's ability to print different hues; it also faded the printer's primary ink colors to white and black. We looked for a color printer's ability to lay down primary colors adjacent to each other without smear-

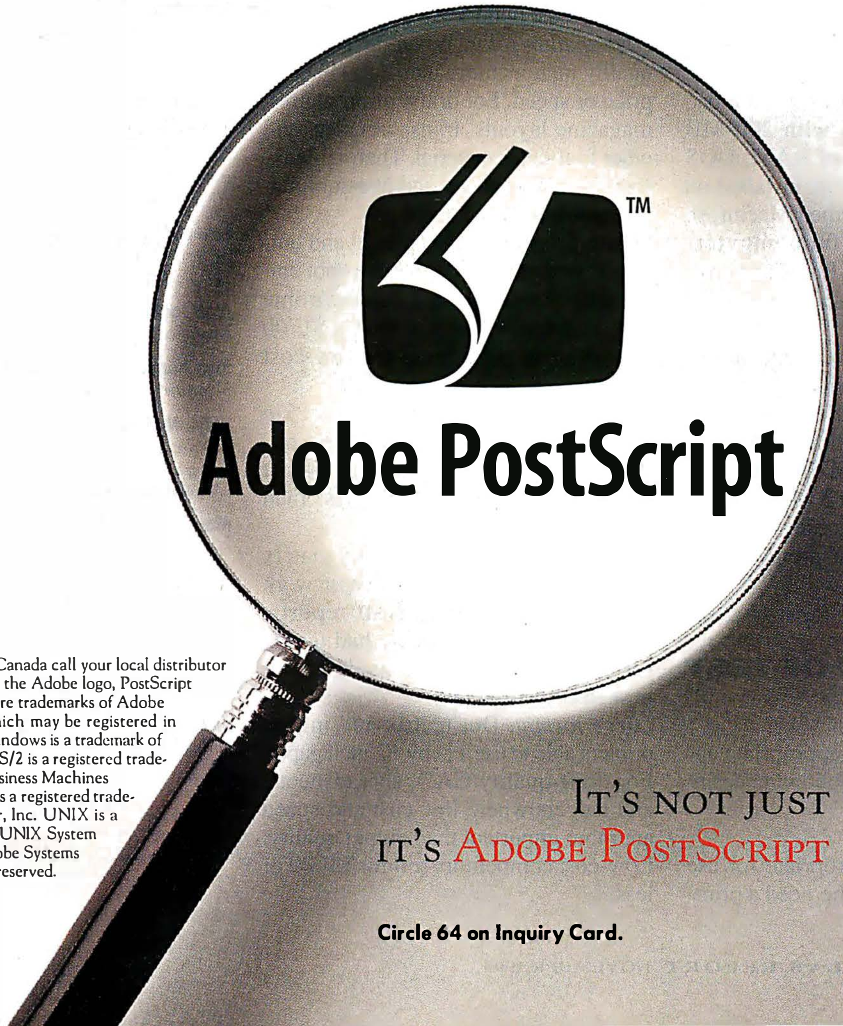


Line Test

There's just one choice: Insist upon a printer with genuine Adobe™ PostScript™ software inside. It's the industry standard—the only way to guarantee that your printer will work with virtually every software application and hardware environment today and tomorrow. With Adobe PostScript, you're assured the highest quality output whether you're printing from DOS, Windows™, OS/2®, Macintosh® or UNIX®, from a PC or a mainframe. And since almost every major printer manufacturer offers

THE MOST IMPORTANT CHOICE YOU'LL MAKE WHEN CHOOSING A PRINTER, ISN'T JUST THE PRINTER.

Adobe PostScript printers, it's easy to choose the brand of printer that's right for your company. Remember, the best choice is the clear choice. Make sure your next printer has genuine Adobe PostScript. Accept no substitutes. For a free guide on how to choose a printer, call 1-800-962-3623, Dept. L, Ext. 0106.



IT'S NOT JUST PRINTING, IT'S ADOBE POSTSCRIPT PRINTING.

Adobe™

Circle 64 on Inquiry Card.

ing. We also assessed the effectiveness of the printer's screening and dithering, and we looked for a minimum of random specks of ink and alignment errors, which detract from the output's appearance.

The quality tests were written in PostScript. To generate quality test pages for non-PostScript printers, we used the Freedom of Press PostScript interpreter from ColorAge. To measure print quality, we examined the output from all the printers and selected the one that best met our quality standards. Output from all the other printers was ranked in relation to the best sample.



Our testing team. Front, from left: Siva Kumar, André Whittle, Alan Joch. Back, from left: Jim Hurd, Vidya Maharaj, Helen Holzbaur, Stephen Platt, and Morgan Nec.

FEATURES AND EASE OF USE

Features and usability go hand in hand. We noted each printer's features, as well as any important capabilities a printer may have lacked. We also noted how easy it was to use each printer.

CONFIGURATIONS

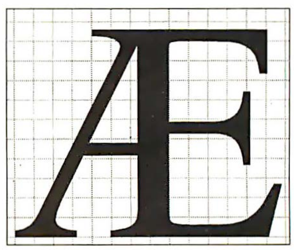
We performed PC tests using Compaq Deskpro 433i systems with 200-MB hard drives and 8 MB of RAM. DOS 5.0 and Windows 3.1 were installed on each system. We performed Macintosh tests using Quadra 700 computers equipped with 8 MB of RAM and 400-MB hard drives. We used System 7.1 for all Mac testing.

All print servers, spoolers, and buffers were disabled. When soliciting printers, we requested each manufacturer's standard memory configuration for dot-matrix and ink-jet printers. Workgroup laser printers required at least 8 MB of RAM and PostScript, if available. All other lasers needed 4 MB of memory and PostScript if available.

BREAKDOWN OF TEST CATEGORIES

We sorted printers for appropriate applications by using the following definitions.

General business. Appropriate for use by one to five people who need a printer for business correspondence, proposals, reports, and limited desktop publishing. Requirements for high-quality output limited our rankings to laser printers. A printer's output quality weighed equally with its performance. Printers that were rated at 6 ppm or slower and priced at less than $900 were considered for low-cost honors.



Font Test

High-quality color. When quality matters more than price or speed. For drafts of brochures, magazine layouts, transparencies, and other four-color material. Thermal-wax-transfer, solid ink-jet, and dye-sublimation printers were ranked.

General-purpose color. Ink-jet and dot-matrix printers for color drafts, spot color, transparencies, and monochrome text. Printers that were priced at $1700 or less were considered for low-cost honors.

Workgroups. Laser printers rated at 15 to 20 ppm. Speed, quality, and connectivity were key considerations. Low-cost competitors carried prices of less than $4000.

Draft quality. Ink-jet and dot-matrix printers to serve single users whose work consists of producing draft reports, forms, and labels. Printers had to sell for $600 or less to be considered for best-low-cost status.

Large format. Dot-matrix and ink-jet printers able to use 11- by 17-inch paper. For draft-quality CAD, spreadsheets, and ledgers where low cost and speed are more important than output quality. Low-cost competitors sell for $1000 or less.

CAD and DTP. Lasers for high-quality output and 11- by 17-inch printing. Printers selling for $4000 or less were considered for low-cost honors.

Portable. Thermal, ink-jet, and dot-matrix printers that can run on batteries and are also light enough for easy travel. To be ranked for low-cost status, printers had to sell for less than $500.

OUR TEST TEAM

Jim Hurd, *Vice President of Research and Development/NSTL, wrote the printer performance tests. He has tested scores of printers during the last 10 years at NSTL.*

Helen Holzbaur, *Project Manager/NSTL, was a network manager and systems administrator at Temple University for 10 years before joining NSTL.*

Alan Joch, *Senior Editor/BYTE, coordinates the combined testing between the BYTE Lab and NSTL.*

Siva Kumar, *Technical Analyst/NSTL, specializes in hardware and network-operating-systems testing.*

Vidya Maharaj, *Consultant/NSTL, helped evaluate 120 printers for the Canadian government earlier this year. She is completing a B.S. degree in computer science from the University of Toronto.*

Morgan Nec, *Consultant/NSTL, has tested printers and systems for NSTL since 1988.*

Stephen Platt, *Manager of Unix Development/NSTL, has a doctorate in computer science/computer graphics and wrote the quality tests for this report.*

André Whittle, *Consultant/NSTL, has evaluated computer hardware for the Canadian government, including a large-scale printer test conducted last spring.*

The Lab Report is an ongoing collaborative project between BYTE Magazine and National Software Testing Laboratories (NSTL). BYTE Magazine and NSTL are both operating units of McGraw-Hill, Inc.



Us.

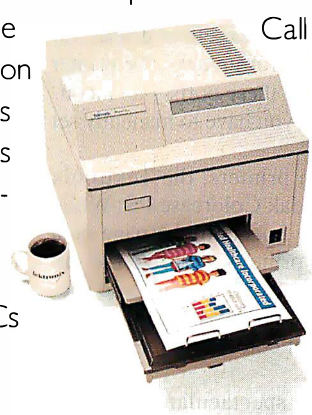
Them.

We'd like to compare our color prints to theirs, but we don't have all day.

When you can get photo-like output like this from a dye-sublimation printer, who wants to wait? Especially when you can use that vivid, continuous-tone color for everything from overhead transparencies to proofing your layouts before going to film.

That's why we made the new Phaser™ IISDX the fastest Adobe™ PostScript™ Level 2 dye-sublimation printer around. Its powerful RISC CPU processes large scanned images at about the same speed as a dedicated raster printer, but with all the convenience and shareability you've come to expect from a network PostScript printer.

The Phaser IISDX can be shared with Macs, PCs (Windows/DOS or OS/2), and workstations—simultaneously. It switches automatically from user to user using its parallel, serial, AppleTalk,® or optional EtherTalk™ and TCP/IP Ethernet™ ports. And it's as simple to operate and maintain as a standard office laser printer.



Call us today for a free sample print. Our number is 800/835-6100, Department 29-J.

For faxed information, call 503/682-7450 and ask for document 1231.

Tektronix

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THE BEST PRINTERS FOR

HIGH-QUALITY COLOR

We tested 13 printers that excel in applications where proofs for color publications and top-quality transparencies demand the best color, no matter what the cost. These thermal-wax-transfer and dye-sublimation models are among the most precise printers for placing color pigment on a printed page. In most cases, the output from this class of high-priced printers was of near-photographic quality.

On our 10-point scale, where higher numbers indicate better quality, thermal-transfer printers received scores ranging from the Star Micronics SJ 144's 5.75 to the Tektronix Phaser III PXi's 8.29. The dye-sublimation Textronix Phaser IISDX scored a near-perfect 9.29.

Although prices for high-end color printers have dropped in relative terms over the last year, none of these printers is cheap. The "low-cost" Phaser 200e lists for $3695. To get the top-quality output of the Phaser IISDX, however, expect to pay a list price of $9995, the highest price of any printer we evaluated for this report.

In addition, none of these printers is particularly speedy, and therefore should not be considered for doing double duty in other types of printing applications. For example, the Spectra Star GT, from General Parametrics, was the fastest, with a speed of about 1 ppm in our tests. Most of the rest were in the 0.3- to 0.5-ppm range, with the slowest being the Eastman Kodak Colorease PS at 0.16 ppm (or 6 minutes per page).

Our choice for best overall in this category was a thermal-wax-transfer model, the Spectra Star GT. It was the fastest printer in the category, and it scored well on most of our quality tests. Its scores on the monochrome quality tests were average, as were those of all the thermal-transfer printers we reviewed. The technology just isn't designed for placing text on a page. However, the Spectra's color-quality score of 7.71 points out of a possible score of 10, coupled with its relatively fast print speed, helped make this the best all-around printer.

The Spectra Star GT comes equipped with serial, parallel, and LocalTalk ports, which makes it an excellent printer for PC, Mac, or mixed environments. Unfortunately, the printer does not automatically switch among these ports—an inconvenience in a mixed setting, because you have to manually set the printer for the proper platform.

We tested two dye-sublimation printers, the Tektronix Phaser IISDX and the Eastman Kodak Colorease PS. While thermal-transfer printers melt waxy inks onto the page on a dot-by-dot basis, dye-sublimation printers vaporize the ink (going from solid to vapor, hence the sublimation) onto specially coated paper. This allows better ink blending, finer control of ink deposits, and smoother colors (see the samples in the text box above).

The results are nothing short of spectacular. The color wheel and shade stripes of our color test were almost perfectly smooth on the output from both of these printers. In fact, we needed to examine the paper through a ×30 loupe to see the ink deposits. Typical thermal-transfer and ink-jet output has uneven dot placement, while output from both of the dye-sublimation printers showed fairly smooth, filled-in areas. Instead of visibly dithered dots, the inks blended together seamlessly in the dye-sublimation samples.

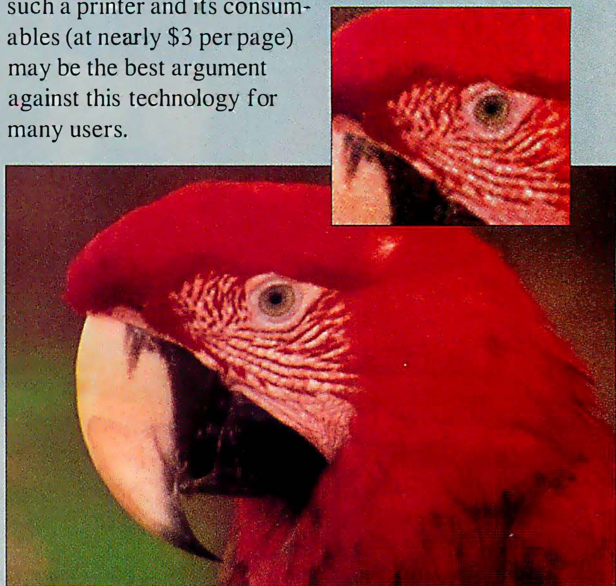
For color reproduction, we found the Phaser IISDX to be slightly better than the Colorease on two of our quality tests. The Phaser IISDX's pigments were slightly stronger and purer, while the Colorease's yellow is more orange, the magenta slightly more bluish, and the cyan slightly paler. Our color-wheel tests indicate that the Phaser IISDX's gamut of colors is larger than the Colorease's, showing that it can print a wider color range.

We also noticed a slight registration problem on the Colorease. When printing fine lines of one color against a background of a differing color, the line was offset slightly. This results in two visible edges, one white (i.e., no pigment deposited) and the other a blend of the two inks.

One warning if you need a color printer for prepublication

Dye Sublimation: Color for Tomorrow?

Dye-sublimation printers produce crisp, clear output by using varying degrees of temperature to transfer color from the ribbon to special paper. The pictures below are the best argument for dye-sublimation printers, although the cost of such a printer and its consumables (at nearly $3 per page) may be the best argument against this technology for many users.



The image on the bottom was produced by the Tektronix Phaser IISDX, the dye-sublimation model with the highest quality score of any color printer we tested. On the top is output from the Tektronix Phaser 200i, a high-quality thermal-wax-transfer printer. Note: Both images were magnified 150 percent to illustrate the dot structure of thermal-wax-transfer printers versus the continuous tones of dye-sublimation technology.

proofs. Many of the printers we tested have a fairly large "grab" area: The top inch or more of the page isn't printable, because the print engine uses this space to hold the paper. The General Parametrics Spectra Star GT, for example, loses slightly more than an inch, while the QMS ColorScript 210 loses almost three-quarters of an inch. Some manufacturers, such as Tektronix, design some of their printers for oversize 14-inch paper, which allows space to hold the paper while preserving an 8½- by 11-inch print area.

Among the thermal-wax-transfer printers, Calcomp's ColorMaster Plus 6613XF posted the highest output-quality scores. Although it doesn't match the quality levels of dye-sublimation printers, its quality is high enough to place it less than a tenth of a point below the Eastman Kodak Colorease PS.

However, the ColorMaster Plus 6613XF is priced to match its quality status: It sells for $1000 more than the Colorease PS. Nevertheless, the Calcomp (as well as other thermal-transfer printers) can accommodate plain paper, which makes it more economical to run than its dye-sublimation competitors.

Two of the solid-ink printers that we tested, Tektronix's Phaser III PXi and DataProducts' Jolt PSe, bring ink-jet printers into the same output-quality league as dye-sublimation and thermal printers. Specially coated paper is not a requirement for solid-ink printers. Although the Phaser III PXi and the Jolt PSe fell short in dye-sublimation quality, they both scored higher in our quality tests than five of the thermal-wax-transfer printers: General Parametrics' Spectra Star GT and Spectra Star Q10E, Tektronix's Phaser 200i and 200e, and the QMS ColorScript 230.

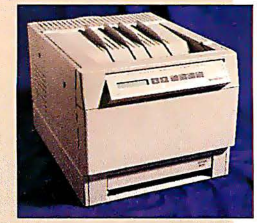
KEY

▲ Laser
■ Ink-jet
● Dot-matrix
◆ Dye-sublimation
★ Thermal

BYTE BEST — HIGH-QUALITY COLOR

For the best in all-around performance...

BEST OVERALL — General Parametrics Spectra Star GT



A good mix of speed and quality push the Spectra Star GT to the top for color printers. It printed our benchmarks at an average of 59 seconds per page, significantly quicker than the next-fastest color printer, the Tektronix Phaser 200i, which averaged 80 seconds per page. Although the Tektronix Phaser IISDX received higher scores for quality, it ran almost three times slower than the Spectra Star GT. Its price is among the lowest for this class of printers, and its ability to handle plain paper helps reduce consumables costs. The 300-dpi Spectra Star GT comes standard with PostScript Level II support.

			BYTE COLOR PERFORMANCE SCORES (PPM) PC POSTSCRIPT	MAC OVERALL	QUALITY INDEX	CLASS (PPM)	PRICE	RESOLUTION (DPI)	SPECIAL PAPER REQUIRED?
BEST	General Parametrics Spectra Star GT	★	1.02	0.93	7.71	2	$4495	300	No
RUNNER-UP	Calcomp ColorMaster Plus 6613XF	★	0.59	0.87	8.27	1	$8995	300	No
RUNNER-UP	Tektronix Phaser 200i	★	0.75	0.99	6.36	2	$5995	300	No
RUNNER-UP	Tektronix Phaser 200e	★	0.57	0.92	7.25	2	$3695	300	No
RUNNER-UP	Tektronix Phaser IISDX	◆	0.27	0.32	9.29	1	$9995	300	Yes

The choice for premium Mac color

MACINTOSH — General Parametrics Spectra Star GT



Mac users also benefit from the Spectra Star GT's speed and quality. Only the Tektronix Phaser 200i was faster in our Macintosh tests, but its output quality was significantly lower (7.71 versus 6.36). Although the Calcomp ColorMaster Plus 6613XF beat the Spectra Star GT for quality and almost matched it for speed, the Calcomp sells for almost twice as much. An advantage shared by these top three Macintosh color printers is their ability to use standard paper, unlike the remaining two runners up.

			BYTE COLOR PERFORMANCE SCORES (PPM) PC POSTSCRIPT	MAC OVERALL	QUALITY INDEX	CLASS (PPM)	PRICE	RESOLUTION (DPI)	SPECIAL PAPER REQUIRED?
BEST	General Parametrics Spectra Star GT	★	1.02	0.93	7.71	2	$4495	300	No
RUNNER-UP	Calcomp ColorMaster Plus 6613XF	★	0.59	0.87	8.27	1	$8995	300	No
RUNNER-UP	Tektronix Phaser 200i	★	0.75	0.99	6.36	2	$5995	300	No
RUNNER-UP	General Parametrics Spectra Star Q10E	★	0.31	0.68	7.00	1.3	$2999	300	Yes
RUNNER-UP	QMS ColorScript 230	★	0.34	0.58	7.69	1	$7995	300	Yes

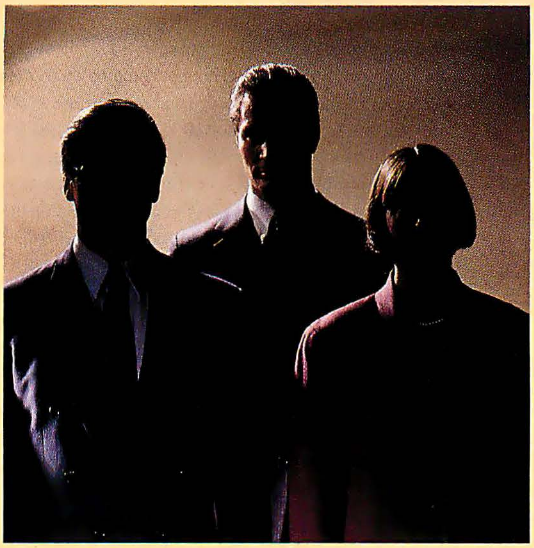
Need the best four-color output?

HIGH QUALITY — Tektronix Phaser IISDX



We could distinguish the output of the Tektronix Phaser IISDX from a photograph, but of all the printers we reviewed, the Phaser IISDX produces the most photograph-like output. Its dye-sublimation print engine blends inks together to produce areas of true color. No dither patterns were visible, raising the Phaser IISDX above any other non-dye-sublimation printer. It placed fine lines nearly perfectly, without gaps and with blending that was visible only with the aid of a microscope.

			BYTE COLOR PERFORMANCE SCORES (PPM) PC POSTSCRIPT	MAC OVERALL	QUALITY INDEX	CLASS (PPM)	PRICE	RESOLUTION (DPI)	SPECIAL PAPER REQUIRED?
BEST	Tektronix Phaser IISDX	◆	0.27	0.32	9.29	1	$9995	300	Yes
RUNNER-UP	Eastman Kodak Colorease PS	◆	0.16	0.18	8.34	3.5	$7999	300	Yes
RUNNER-UP	Tektronix Phaser III PXi	■	0.25	0.45	8.29	1	$9995	300	No
RUNNER-UP	Calcomp ColorMaster Plus 6613XF	★	0.59	0.87	8.27	1	$8995	300	No
RUNNER-UP	DataProducts Jolt PSe	■	0.19	0.35	8.19	2	$4995	300	No



The secret HP, Compaq and Lexmark were hoping we wouldn't tell.

Take a close look at their page printers and you'll see: you spend your really big money on disposable printer cartridges.

One HP® LaserJet® 4Si, for example, in a high-volume* network printing environment could easily run up $4,183 in cartridge bills in its first year alone — more than the price of the printer itself. Five Compaq® Pagemarq™ 15s could cost you $22,193 in cartridges. And a year's worth of cartridges for ten Lexmark™ IBM® 4039 16L printers would probably set you back by about $41,611.

If you had no choice, these numbers would simply represent the cost of doing business. But the fact is, you do have a choice.

Cartridge-Free printing

Kyocera® is in the printer business, not the cartridge business. That's why we were free to develop Ecosys® Cartridge-Free printing. And why you can print up to 7,000 pages with an Ecosys printer with a single $49 no-mess Ecotone® toner refill.

CARTRIDGE-FREE TECHNOLOGY WITH A CONSCIENCE

In our high-volume network printing example, choosing an 18-ppm Ecosys FS-3500A over an HP LaserJet 4Si would save you $2,797 a year. Five FS-3500As would save you $15,263 compared with the Compaq solution, while ten FS-3500As would save $27,751 over Lexmark in just one year.

Best of all, you wouldn't give anything up. You'd get consistently high output quality, fast throughput, reliability and full network compatibility.

Cartridge-Free for consistent quality

The traditional laser printer uses disposable cartridges because the traditional drum built into them wears out fast. The Ecosys drum doesn't. Its durable amorphous silicon (a-Si) surface will last a fully-warranted three years/300,000 pages and beyond. Plus, Ecotone toner has ceramic particles to polish and recondition the drum with every page you print. The result for you is consistently clean output over the lifetime of the printer.

So what's the secret?

It's this: to evaluate a printing solution, you've got to consider cost of printing. And for networks with one to 1,000 printers, Ecosys Cartridge-Free printing is inherently more economical — by a wide margin.



How wide? The free Ecosys savings-at-a-glance calculator wheel will help you find out. For yours, or additional information on the Ecosys printer family, call **1-800-2-ECOSYS.**

Now that you know the secret, the only question is, how much can you save?



From the 10-ppm FS-1500A to the 18-ppm FS-3500A (shown alone and with full complement of paper handling options), Ecosys Cartridge-Free printers deliver world-class quality, performance and support with unprecedented economy.

KYOCERA

TECHNOLOGY WITH A CONSCIENCE.

*All comparisons based on InfoCorp values: 5% average page coverage; "high-volume" = 16,500 pages/month. Retail prices (8/93)/InfoCorp yields used for calculations: HP 4Si cartridge—$169/8,000 pages; Compaq 15 cartridge—$269/12,000 pages; Lexmark 16L cartridge—$269/12,800 pages. To calculate: Cartridge price ÷ yield at 5% = cost-per-page; cost-per-page x total annual volume = annual cartridge expense.

PC MAGAZINE EDITORS' CHOICE November 24, 1992 Ecosys a-Si Printer FS-1500A

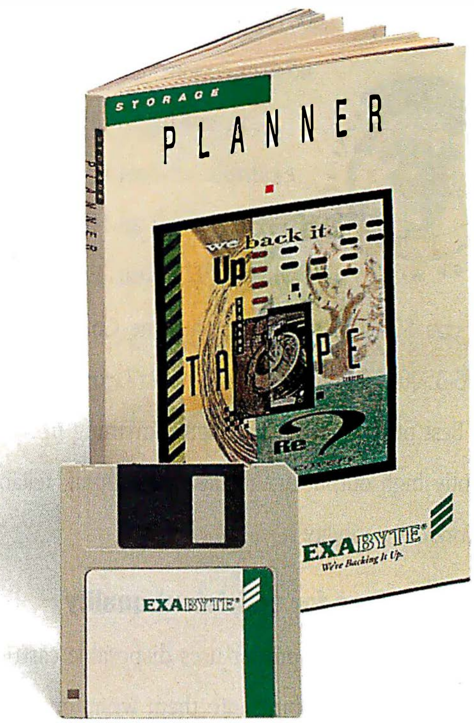
BUYERS ASSURANCE SEAL — RECOMMENDED PRODUCT

1992 BYTE AWARD OF EXCELLENCE

1992 - WINNER - PC Magazine Award for Technical Excellence — Kyocera Ecosys a-Si Printer FS-1500A, Kyocera Electronics, Inc.

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BYTE BEST

GENERAL-PURPOSE COLOR

The best for color and monochrome output

A color printer to be used for reports and presentations doesn't have the same quality requirements as thermal-wax-transfer or dye-sublimation printers for prepress and other high-end color uses. For one thing, printers in the general-purpose category must be able to produce crisp monochrome text. Nevertheless, the color-output quality of these printers should still make you look good. Compared to their high-end color cousins, general-purpose color printers must run faster and offer more economical (under $1 per page) consumables costs.

We found six color ink-jet printers and 20 dot-matrix printers that performed admirably in this regard. The rated printers also produced top-quality transparencies. Colors remained saturated and solid and did not smear or peel on either medium. On the other hand, we found that color dot-matrix printers, such as the DEC LA 95-DECWriter (which otherwise produces reasonable-quality output), do not print well on transparency film because of ink smearing.

Performance from color ink-jet printers is slow compared to that of monochrome printers. Don't buy a color printer as your primary printer unless all you do is prepare charts and overhead transparencies.

The fastest of the printers rated in this category achieved a score of only three-quarters of a page per minute, while the fastest monochrome ink-jets ran at 2 ppm. Ink-jet color cartridges cost approximately $25 to $35 and should last for about 400 to 700 pages.

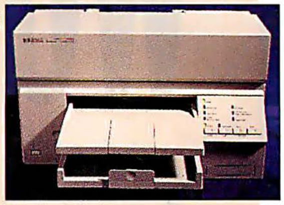
KEY

▲ Laser ■ Ink-jet
● Dot-matrix ◆ Dye-sublimation
★ Thermal

BEST OVERALL — Hewlett-Packard DeskJet 1200C/PS

NOVEMBER 1993 BYTE BEST GENERAL-PURPOSE COLOR PRINTER

This printer produced the best balance of high-quality color and monochrome output of any printer we tested. With a speed rating of 72 ppm, it was also the fastest color ink-jet printer we tested. It comes with color-matching software that helps ensure the color you specify is the color you'll get on the printed page.



BYTE PERFORMANCE SCORES (PPM)

			PC DRAFT		PC POSTSCRIPT		MACINTOSH		QUALITY			RESOLUTION
			B&W	COLOR	B&W	COLOR	B&W	COLOR	INDEX	CLASS	PRICE	(DPI)
BEST	HP DeskJet 1200C/PS	■	1.94	0.72	1.77	0.34	1.38	0.69	7.29	1 ppm	$2399	600[1]
RUNNER-UP	Canon BJC-800	■	1.09	0.68	—	—	—	—	7.33	300 cps	$1999	360
RUNNER-UP	Lexmark IBM Color JetPrinter PS4079	■	—	—	0.75	0.24	0.70	0.41	7.87	167 cps	$3199	360

Sacrifice PostScript, save money

LOW COST — Hewlett-Packard DeskJet 1200C



Without PostScript capabilities, the 1200C lists for $700 less than the 1200C/PS and still far outperforms inexpensive ink-jets like the HP DeskJet 550C. If your budget demands the lowest cost, consider the LA 95-DECWriter, a $319 color printer that led the dot-matrix field in output quality.

BYTE PERFORMANCE SCORES (PPM)

			PC DRAFT		PC POSTSCRIPT		MACINTOSH		QUALITY			RESOLUTION
			B&W	COLOR	B&W	COLOR	B&W	COLOR	INDEX	CLASS	PRICE	(DPI)
BEST	HP DeskJet 1200C	■	1.94	0.72	—	—	1.38	0.69	7.29	7 ppm	$1699	600[1]
RUNNER-UP	DEC LA 95-DECWriter	●	1.85	0.57	—	—	—	—	5.06	300 cps	$319	360
RUNNER-UP	Okidata Microline 590	●	3.70	0.62	—	—	—	—	3.56	360 cps	$699	360
RUNNER-UP	HP DeskJet 550C	■	1.94	0.61	—	—	—	—	4.86	240 cps	$719	300
RUNNER-UP	Citizen GSX-190	●	2.41	0.55	—	—	—	—	3.86	270 cps	$199	240

Need the best for Mac color and text?

MACINTOSH — Apple ColorPrinter



The Apple ColorPrinter was the fastest printer for Macintosh color. Its ColorSync feature supports color matching with other Apple devices. Its output quality is just barely lower than that of the HP DeskJet 1200C/PS.

BYTE PERFORMANCE SCORES (PPM)

			PC DRAFT		PC POSTSCRIPT		MACINTOSH		QUALITY			RESOLUTION
			B&W	COLOR	B&W	COLOR	B&W	COLOR	INDEX	CLASS	PRICE	(DPI)
BEST	Apple ColorPrinter	■	—	—	—	—	0.89	0.73	6.93	3.5 ppm	$1659	360
RUNNER-UP	HP DeskJet 1200C/PS	■	1.94	0.72	1.77	0.34	1.38	0.69	7.29	1 ppm	$2399	600[1]
RUNNER-UP	HP PaintJet XL300	■	0.43	0.27	0.39	0.12	0.35	0.18	7.35	2 ppm	$2795	300

When output quality matters...

HIGH QUALITY — Hewlett-Packard DeskJet 1200C/PS



The HP DeskJet 1200C/PS's combined color and monochrome quality scores were the best for any of the color ink-jet printers, thanks to its 600- by 300-dpi resolution in monochrome text mode.

BYTE PERFORMANCE SCORES (PPM)

			PC DRAFT		PC POSTSCRIPT		MACINTOSH		QUALITY			RESOLUTION
			B&W	COLOR	B&W	COLOR	B&W	COLOR	INDEX	CLASS	PRICE	(DPI)
BEST	HP DeskJet 1200C/PS	■	1.94	0.72	1.77	0.34	1.38	0.69	7.29	1 ppm	$2399	600[1]
RUNNER-UP	Lexmark IBM Color JetPrinter PS4079	■	—	—	0.75	0.24	0.70	0.41	7.87	167 cps	$3199	360
RUNNER-UP	HP PaintJet XL300	■	0.43	0.27	0.39	0.12	0.35	0.18	7.35	2 ppm	$2795	300

[1] Monochrome text mode.

THE BEST PRINTERS FOR WORKGROUPS

If you have ever sat in a print queue while a coworker produced a large mailing, you know that speed matters for a shared printer. The laser printers we evaluated for network use were rated at 15 ppm or faster and can handle print jobs from approximately five to 50 people. Most of these printers can be attached directly to your Ethernet, Token Ring, or LocalTalk network. However, while direct network attachment can provide a noticeable speedup on documents with large scanned images, this capability is generally more of a convenience than a speed boost.

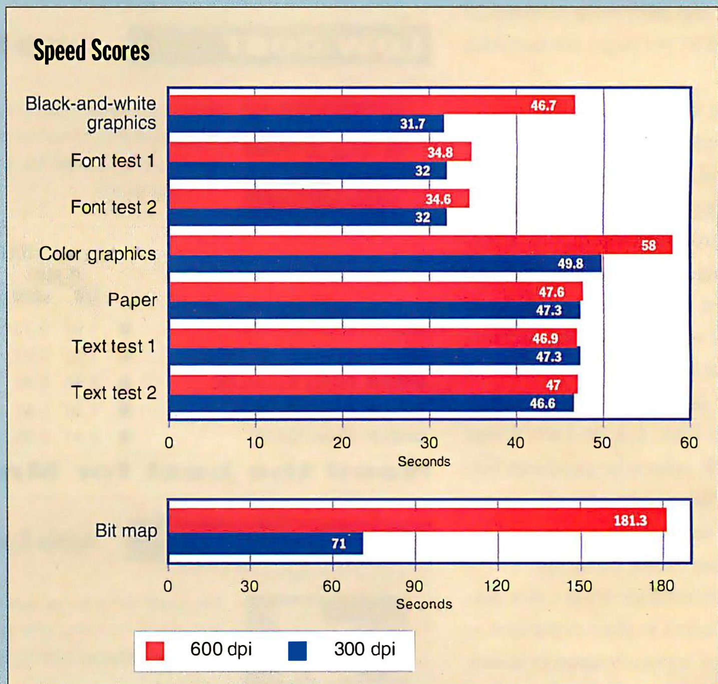
The printers ranked in this section have duty cycles of 25,000 pages per month or more; anything less couldn't sustain the print load of a large workgroup. Not included in this category are the tabloid (11- by 17-inch) printers (see the CAD and desktop publishing section for a comparison of tabloid-capable lasers).

Only four of the workgroup printers we tested offered 600-dpi resolution: the HP LaserJet 4SiMx, the Lexmark IBM 4039Laser 12L and 16L, and the QMS 1725 Print System. Not surprisingly, these four provide the best quality and make up our short list for workgroup printer recommendations.

As standard equipment or options, almost every feature imaginable comes with workgroup printers: PostScript, hard drives, fax modems, and Ethernet interfaces are de rigueur. In addition, we consider automatic emulation switching a must, as well as support for NetWare and AppleTalk.

600 VS. 300: TRADING SPEED FOR QUALITY

If you want the best-looking output, you'll have to pay a price. As this figure of averaged 600- and 300-dpi printers shows, printing at 600 dpi greatly adds to the time it takes to print graphical images, such as bit maps and scanned photos, compared to 300-dpi printers.



The LaserJet 4SiMx took top honors in this category. It supports Adobe PostScript Level II, the state of the art for graphical illustrations and desktop publishing. The quality of its text output is particularly good. It provides the best overall performance of any printer we tested. It was by far the fastest for printing from the Macintosh, and second only to the Compaq PageMarq 20 (see the CAD and desktop publishing section) for PostScript printing from the Macintosh. It supports the broadest range of network protocols and paper-handling options. Its 1000-sheet input capacity is double that of competitors such as the Lexmark IBM 4039Laser 16L, which offers a 500-sheet capacity.

Nevertheless, the 4039Laser 16L was the 4SiMx's main competition, thanks in part to a list price that's over $2000 lower. Like all the Lexmark laser printers, the 4039Laser 16L provides blistering speed when used with Lexmark's Windows drivers, power management, a duplexing option, an excellent five-line LCD for configuration, and flash ROM to store fonts and logos. The 4039Laser 16L also provides credible PostScript performance.

The faster software raster-image processor does not produce graphics with the same quality as the PhoenixPage PostScript Level I–compatible interpreter, which does not yet incorporate all the features of Level II. In addition, the interpreter renders graphics differently (though not necessarily worse) than the Adobe product. The 4039Laser 16L does not support as wide a range of networking protocols as the 4SiMx; for example, Macs cannot yet access the 4039Laser 16L over Ethernet (LocalTalk is an option).

The 4039Laser 12L is a lower-cost, lower-performance version of the 4039Laser 16L. The two are identical except for performance and can use the same network cards and paper-handling options. With both printers, two trays with a maximum capacity of 500 sheets come standard. Like the

16L, the 12L does not yet support EtherTalk.

The Kyocera Ecosys FS-3500A touts an "environmentally sound" hardened drum that you do not replace with the toner. The performance of the FS-3500A is excellent; its PostScript speed was one of the fastest we saw, as was its PCL performance. Quality was average for a 300-dpi printer, and it was inferior to that of the 600-dpi 4SiMx and the 4039-Laser 16L. Kyocera's EtherTalk support was in beta at the time of our tests.

The QMS 1725 Print System uses the same print engine as the 4SiMx, but when rendering a page rich in fonts, the 1725 takes up to 36 percent longer than the 4SiMx and as much as 240 percent longer than the 4039Laser 12L. Although the 1725 renders pages at 600 dpi, its enhanced 300-dpi engine cannot produce the same high-quality output as the best 600-dpi engines.

If you are specifically looking for low cost for high-volume DOS applications such as billing and database listings, the TI MicroLaser XL is a good choice. It was the least expensive printer in this class ($2399), and for printing raw ASCII text streams it was faster than every other printer except the Compaq PageMarq 20. The Sharp engine in the MicroLaser XL also has a very low cost per page.

The MicroLaser XL Turbo is a souped-up version of the XL for faster PostScript printing. The Turbo adapter produced better than a 300 percent speed improvement under PostScript. But even with the Turbo upgrade, PostScript output was slower overall than on TI's 8-ppm MicroLaser Pro 600. We judged its output quality to be poorest in this class of printers because of fuzzy text that was illegible at small point sizes.

The Genicom 7170 and the Toshiba Pagelaser GX400 are virtually identical physically, even down to the menu structure and documentation. Both lacked Macintosh connectivity, a serious flaw for a workgroup computer. The Genicom 7170 is faster and less expensive, but both of these devices performed poorly. Their quality was average for their 300-dpi engines.

BYTE BEST — WORKGROUPS

Want the best in speed and connectivity?

BEST OVERALL — **Hewlett Packard LaserJet 4SiMx**



The 4SiMx is a joy to use: It has superb quality and fast performance, and it's easy to configure. It flawlessly accepted PCL and PostScript jobs from our network, and only one other printer's output was better than that created by the 4SiMx's 600-dpi engine. Photos printed a little better on the Lexmark IBM 4039Laser printers due to their PictureGrade technology, but the 4SiMx was better for text and graphics. The 4SiMx also supports a broad range of network protocols and paper-handling options.

			BYTE PERFORMANCE SCORES (PPM) PC DRAFT	PC POSTSCRIPT	MAC OVERALL	QUALITY INDEX	CLASS (PPM)	PRICE	RESOLUTION (DPI)	AUTOMATIC EMULATION SWITCHING?
BEST	HP LaserJet 4SiMx	▲	9.65	5.86	8.05	8.72	17	$5499	600	Yes
RUNNER-UP	Lexmark IBM 4039Laser 12L	▲	8.68	3.55	5.00	8.81	12	$2899	600	Yes
RUNNER-UP	Lexmark IBM 4039Laser 16L	▲	11.37	3.71	5.67	8.44	16	$3399	600	Yes
RUNNER-UP	QMS 1725 Print System	▲	6.49	3.51	4.05	8.44	17	$4999	600	Yes
RUNNER-UP	Kyocera Ecosys FS-3500A	▲	6.34	5.97	—	6.33	18	$3895	300	Yes

Budget-conscious?

LOW COST — **Lexmark IBM 4039Laser 12L**

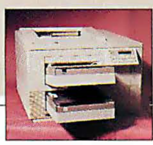


The Lexmark IBM 4039Laser 12L is a great 600-dpi workgroup printer for a very attractive price. At under $3000 for PCL and PostScript, the 12L is priced liked 8-ppm printers, yet it outperforms 16- and 17-ppm models. The print quality is superb when used with PostScript and above average using PCL. Duplex printing can be added for under $700. Unfortunately, EtherTalk support for Macintosh users is not available.

			BYTE PERFORMANCE SCORES (PPM) PC DRAFT	PC POSTSCRIPT	MAC OVERALL	QUALITY INDEX	CLASS (PPM)	PRICE	RESOLUTION (DPI)	AUTOMATIC EMULATION SWITCHING?
BEST	Lexmark IBM 4039Laser 12L	▲	8.68	3.55	5.00	8.81	12	$2899	600	Yes
RUNNER-UP	Lexmark IBM 4039Laser 16L	▲	11.37	3.71	5.67	8.44	16	$3399	600	Yes
RUNNER-UP	Kyocera Ecosys FS-3500A	▲	6.34	5.97	—	6.33	18	$3895	300	Yes
RUNNER-UP	Genicom 7170	▲	4.04	3.59	—	6.56	17	$3725	300	Yes
RUNNER-UP	TI MicroLaser XL Turbo	▲	5.55	4.32	3.99	5.78	16	$3649	300	Yes

Is EtherTalk essential?

MACINTOSH — **HP LaserJet 4SiMx**



The competition here wasn't even close. The 4SiMx's EtherTalk support is automatic and flawless, while its 8.1-ppm score was the fastest Mac speed of any printer we tested (more than 3 ppm faster than the runner-up Lexmark IBM 4039Laser 16L).

			BYTE PERFORMANCE SCORES (PPM) PC DRAFT	PC POSTSCRIPT	MAC OVERALL	QUALITY INDEX	CLASS (PPM)	PRICE	RESOLUTION (DPI)	AUTOMATIC EMULATION SWITCHING?
BEST	HP LaserJet 4SiMx	▲	9.65	5.86	8.05	8.72	17	$5499	600	Yes
RUNNER-UP	Lexmark IBM 4039Laser 16L	▲	11.37	3.71	5.67	8.44	16	$3399	600	Yes
RUNNER-UP	Lexmark IBM 4039Laser 12L	▲	8.68	3.55	5.00	8.81	12	$2899	600	Yes
RUNNER-UP	QMS 1725 Print System	▲	6.49	3.51	4.05	8.44	17	$4999	600	Yes
RUNNER-UP	TI MicroLaser XL Turbo	▲	5.55	4.32	3.99	5.78	16	$3649	300	Yes

KEY

- ▲ Laser
- ■ Ink-jet
- ● Dot-matrix
- ◆ Dye-sublimation
- ★ Thermal


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Photo Quality Output!
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BYTE BEST

DRAFT QUALITY

Small and low-cost printers still fill a niche in many offices for quick printing of draft reports, forms, and labels. In this section, we evaluate narrow-carriage dot-matrix and ink-jet printers designed to be used by one person. Most businesses need at least one dot-matrix printer for multipart forms or large label-printing jobs that require adjustable tractors and straight-through paper paths.

Unlike the water-soluble inks used in ink-jets, dot-matrix output won't smear when wet. As a rule, the simplicity of dot-matrix printers makes them more rugged than models that use other, more complex printing technologies.

By comparison, ink-jet printers are quieter, and their output quality is usually better. Dot-matrix printers tend to be faster than ink-jets in draft mode but slower in letter-quality mode, because dot-matrix printers need two passes (versus one pass by ink-jets) to produce high-resolution text and graphics.

The best dot-matrix printer we tested was the Okidata Microline 590. Okidata has long been known for building tough printers, and the 590 is not only built like a tank, but it's also fast and easy to use. Its monochrome output quality is well above average. Another plus: The 590 produced some of the finest color output we saw from a dot-matrix printer.

The Brother HJ 400 is a good choice for double duty between a Mac and a PC. It is one of the only personal printers that comes standard with both Mac and Windows drivers.

KEY

▲ Laser	■ Ink-jet
● Dot-matrix	◆ Dye-sublimation
★ Thermal	

Need speed versus quality?

BEST OVERALL — **C-Tech Electronics Speedjet 300**



This ink-jet (and its twin, the TI MicroMarc) distinguished itself by its speed: It was the fastest ink-jet printer and outperformed five laser printers. The Speedjet has excellent paper-handling capabilities: We never saw it double-feed pages. Its output quality was also excellent.

			BYTE PERFORMANCE SCORES (PPM) PC DRAFT	MAC	QUALITY INDEX	CLASS	PRICE	RESOLUTION (DPI)	MEMORY (KB) STAN., MAX.	WARRANTY (YEARS)
BEST	C-Tech Electronics Speedjet 300	■	2.23	—	4.67	300 cps	$419	300	16, 512	2
RUNNER-UP	Okidata Microline 590	●	3.70	—	3.56	360 cps	$699	360	64, 64	1
RUNNER-UP	Brother HJ 400	■	2.67	1.23	5.00	110 cps	$419	360	64, 64	2
RUNNER-UP	TI MicroMarc	■	2.27	—	4.28	300 cps	$369	300	24, 24	1
RUNNER-UP	Epson Stylus 800	■	1.50	—	5.00	150 cps	$449	360	32, 32	2

Require the lowest price?

LOW COST — **DEC LA 95-DECWriter**

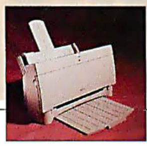


The DECWriter 24-pin dot-matrix printer produced some of the nicest-quality output of any dot-matrix we've ever tested. The DECWriter ran at an acceptable 1.85 ppm.

			BYTE PERFORMANCE SCORES (PPM) PC DRAFT	MAC	QUALITY INDEX	CLASS	PRICE	RESOLUTION (DPI)	MEMORY (KB) STAN., MAX.	WARRANTY (YEARS)
BEST	DEC LA 95-DECWriter	●	1.85	—	4.67	300 cps	$319	360	8, 136	2
RUNNER-UP	Epson AP-5000+	●	2.70	—	4.28	269 cps	$349	360	8, 40	2
RUNNER-UP	Tandy DMP 250	●	1.96	—	3.78	200 cps	$400	360	8, 128	1
RUNNER-UP	Citizen GSX-240	●	1.32	—	4.28	300 cps	$349	360	8, 136	2
RUNNER-UP	Panasonic KXP-2124	●	1.62	—	4.33	300 cps	$370	360	20, 52	2

Low cost for the Mac?

MACINTOSH — **Apple StyleWriter II**

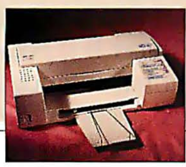


The fastest Mac printer in its class, the StyleWriter II also produced the best quality of the Mac printers. The one major drawback is its limited paper capacity: We could not achieve the stated 100-sheet capacity without causing paper jamming.

			BYTE PERFORMANCE SCORES (PPM) PC DRAFT	MAC	QUALITY INDEX	CLASS	PRICE	RESOLUTION (DPI)	MEMORY (KB) STAN., MAX.	WARRANTY (YEARS)
BEST	Apple StyleWriter II	■	—	1.77	5.11	2 ppm	$359	360	128, 128	—
RUNNER-UP	Brother HJ 400	■	2.67	1.23	5.00	110 cps	$419	360	64, 64	2
RUNNER-UP	HP DeskJet 500	■	2.15	1.61	3.39	240 cps	$365	300	16, 512	3

When quality still matters...

HIGH QUALITY — **Epson Stylus 800**



Although the Stylus 800 and the Brother HJ 400 achieved the same overall score, a page-to-page showdown shows that the Stylus 800 remains the next-best thing to a laser printer. The near-absence of the stray ink particles that are typical of most ink-jets is truly amazing, and curves are rendered flawlessly.

			BYTE PERFORMANCE SCORES (PPM) PC DRAFT	MAC	QUALITY INDEX	CLASS	PRICE	RESOLUTION (DPI)	MEMORY (KB) STAN., MAX.	WARRANTY (YEARS)
BEST	Epson Stylus 800	■	1.50	—	5.00	150 cps	$449	360	32, 32	2
RUNNER-UP	Apple StyleWriter II	■	—	1.77	5.11	2 ppm	$359	360	128, 128	—
RUNNER-UP	Brother HJ 400	■	2.67	1.23	5.00	110 cps	$419	360	64, 64	2



What you need is the new ProTracer II.

It's small enough to sit on your desktop. At 360 dpi, it prints crisp text, precise lines and the smoothest of curves. Its speed is undeniable. And its price — unheard of in the world of CAD.

Called ProTracer™ II, it's a large format inkjet plotter that brings something new to CAD. Versatility. Because not only does ProTracer II produce impressive drawings up to 17"x 22" in size, but it also delivers sharp, high quality text documents.

ProTracer II has an abundance of new features and capabilities all aimed at making you more productive. Like its speed enhancements. And its expanded plotting capabilities including a larger printable area, auto-centering, best fit, replot, and long axis plotting functions.

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PACIFIC DATA PRODUCTS

LARGE FORMAT

Reports, invoices, forms, and labels on large-size paper, where quality is not nearly as important as speed, is where 24-pin dot-matrix printers shine. The wide-carriage ink-jets we tested had superior quality to, but significantly slower performance than, their dot-matrix competition. However, these ink-jets make good alternatives to expensive tabloid laser printers for CAD drawings.

Several dot-matrix printers in this category were fast enough to outperform the slowest general-purpose lasers. The Mannesmann Tally MT 360 is the fastest printer in this group—and the most expensive, with a list price of $2695. Although it can handle a wide variety of paper types, loading the paper is awkward. On the plus side, the MT 360 has an LED panel that is easy to read and understand, and it's easy to set DIP switches for fonts, pitch, and paper widths.

Our favorite dot-matrix printer costing under $1000 was the Epson LQ-1170. It is a durable wide-carriage printer that combines decent speed, average quality, and above-average usability. The control panel on the front of the printer has LEDs indicating the selected font, pitch, and paper. Paper paths are at the front, bottom, and rear of the printer. The printer is noisy, like many other 24-pin dot-matrix printers, especially in 360-dpi mode. Unfortunately, no quiet mode is available. But at just $859, this printer is a bargain in the high-end dot-matrix group.

The Lexmark IBM ExecJet 4072 was one of only two printers in this category that could be used with a Mac, the other being the undependable GCC Wide Writer 360. The ExecJet is a fast printer with average quality, and it has a control panel that controls font, pitch, and paper selection. Unfortunately for Mac users, the documentation leaves much to be desired.

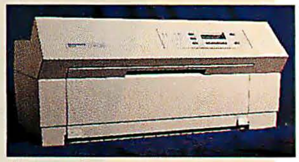
A final note: We also tested Advanced Matrix Technology's Tracjet Model III, which is a unique laser printer that uses pin-feed rather than sheet-feed paper. Its quality is comparable to that of the best dot-matrix printers, and it is 60 percent faster at printing text on forms than the fastest dot-matrix model. On the other hand, it can't print on wide paper and, of course, it is unable to print multiple-part forms. At $6995 retail, you could print faster and less expensively with two high-speed dot-matrix printers.

Need speed and 11- by 17-inch capabilities?

BEST OVERALL — Mannesmann Tally MT 360

NOVEMBER 1993 BYTE BEST LARGE-FORMAT PRINTER

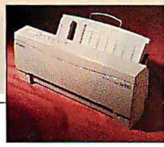
At more than 4 ppm, this is the fastest dot-matrix printer in this class. Speed, combined with below-average quality, make this unit a good choice for high-volume printing of multipart forms and continuous-feed stock. Paper loading is easy, and the printer has an MTBF rating of 10,000 hours.



			PERFORMANCE PC DRAFT (PPM)	QUALITY INDEX	CLASS	PRICE	RESOLUTION (DPI)	MEMORY (KB) BASE, MAX.	WARRANTY (YEARS)	RESIDENT FONTS
BEST	Mannesmann Tally MT 360	●	5.53	3.67	600 cps	$2695	360	128, 128	1	9
RUNNER-UP	Canon BJ-230	■	2.71	4.56	173 cps	$549	360	42, 42	2	5
RUNNER-UP	Epson LQ-1170	●	3.27	4.33	415 cps	$859	360	24, 40	2	12
RUNNER-UP	Fujitsu DL5800	●	3.06	3.67	420 cps	$1595	360	32, 32	2	7

Large carriage, low price?

LOW COST — Canon BJ-230

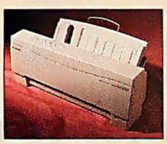


The BJ-230 combines good quality, excellent performance, and an under-$600 price tag. The printer can produce oversize reports, as well as labels and envelopes, at an average speed of more than 2 ppm, which was the fastest performance among the low-cost printers.

			PERFORMANCE PC DRAFT (PPM)	QUALITY INDEX	CLASS	PRICE	RESOLUTION (DPI)	MEMORY (KB) BASE, MAX.	WARRANTY (YEARS)	RESIDENT FONTS
BEST	Canon BJ-230	■	2.71	4.56	173 cps	$549	360	42, 42	2	5
RUNNER-UP	Epson LQ-1170	●	3.27	4.33	415 cps	$859	360	24, 40	2	12
RUNNER-UP	Panasonic KXP-2624	●	2.33	3.67	300 cps	$480	360	26, 58	2	11
RUNNER-UP	Okidata Microline 521	●	2.03	2.56	430 cps	$799	288	64, 64	1	2
RUNNER-UP	Epson FX-1170	●	2.01	2.78	380 cps	$499	240	24, 40	2	12

Need sharp text and graphics?

HIGH QUALITY — Canon BJ-230



This economical ink-jet was the clear winner for quality in this category. It doesn't support PostScript, but its ability to draw lines rivals its competitors'. Also, its text is sharp and clear, even using type as small as 4 points. Curves were smoothly drawn, and the printer produced solid black-filled areas. The only way of differentiating its output from a laser's was in the banding caused by its print head, a problem common to ink-jets.

			PERFORMANCE PC DRAFT (PPM)	QUALITY INDEX	CLASS	PRICE	RESOLUTION (DPI)	MEMORY (KB) BASE, MAX.	WARRANTY (YEARS)	RESIDENT FONTS
BEST	Canon BJ-230	■	2.71	4.56	173 cps	$549	360	42, 42	2	5
RUNNER-UP	Lexmark IBM ExecJet 4072	■	0.43	4.39	300 cps	$799	360	30, 128	1	64
RUNNER-UP	Epson LQ-1170	●	3.27	4.33	415 cps	$859	360	24, 40	2	12
RUNNER-UP	Okidata Microline 395	●	2.53	3.89	607 cps	$1499	360	64, 64	—	4
RUNNER-UP	Mannesmann Tally MT 360	●	5.53	3.67	600 cps	$2695	360	128, 128	1	9

KEY

▲ Laser ■ Ink-jet
● Dot-matrix ◆ Dye-sublimation
★ Thermal

Wai
sec

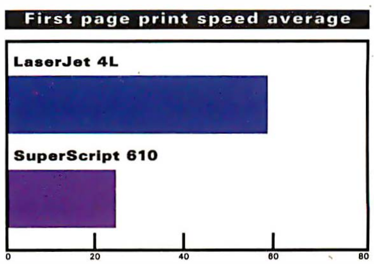
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In fact, the SuperScript 610 is a whole new way of printing. That's because it's the only personal laser printer that directly interfaces with Windows. So it's as upgradable as your PC. That means as your PC gets better, so does your printer. In fact, this printer will print exactly what you see on your screen. Fonts, DOS applications, everything. And at less than $700 it's an even better value than you thought.



Based on 486-66 MHz PC with 8MG RAM. Average speed based on printingone-page documents from word processing, spreadsheet, presentation and graphics applications.

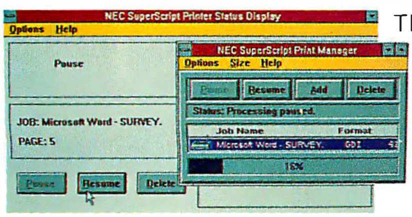
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CAD AND DTP

We tested 10 laser printers designed to handle 11- by 17-inch paper and produce high-quality output for CAD, desktop publishing, and presentation materials. Four of the printers supported resolutions of 1200 dpi, and this clearly showed in the quality of the output: The two LaserMaster Unity printers received almost perfect scores in the quality tests.

The Compaq PageMarq 20 was the performance leader among the tabloid printers. Not only was it the leader in overall and low cost, it and its slower cousin, the PageMarq 15, were the top printers we chose for Macintosh applictions. Although the PageMarq 20's quality was within the top 10 percent of all the printers we tested, its 800- by 400-dpi resolution doesn't match the standards set by the LaserMaster Unity printers, or even that of 600-dpi printers such as the HP LaserJet 4SiMx.

Overall, the printers in this group are workhorses, although some of them work harder than others. The LaserMaster Unity 1200 XLT and XLO, priced at $6995 and $8995, respectively, not only come with the highest resolutions we tested but also have an easy-to-use menu system and can produce full-bleed, camera-ready output.

The QMS 860 Print System has output that is slightly less spectacular. But at under $4600, this printer is a good choice if you need outstanding quality and have a tight budget.

The GCC Select Press 600 is a 600-dpi printer whose output quality was second only to that of the 1200-dpi printers, but with a $4499 price tag. It was the only 600-dpi printer to print full-bleed to the edge of the page. However, one major drawback with this printer is its slow speed, which was barely more than 3 ppm.

The $3725 Genicom 7170 looks like a Compaq PageMarq 20, but it pales in comparison in both performance and quality. The Genicom 7150 fares slightly better in quality comparisons with the Compaq PageMarq 15. The 7150 has an easy-to-use control panel that lets you quickly navigate through the menu structure.

We experienced numerous problems trying to run our Mac and PC tests on NewGen's Turbo PS/660 B. The NewGen ImagerPlus 1200 had even more problems. At the time this article was written, we still could not get the printer to generate the monochrome graphical image or get the bit-map components to run.

KEY

- ▲ Laser
- ■ Ink-jet
- ● Dot-matrix
- ◆ Dye-sublimation
- ★ Thermal

Need laser quality in a large format?

BEST OVERALL — **Compaq PageMarq 20**



The Compaq PageMarq 20 is fast, with a speed rating of 7.7 ppm. Able to handle large-format paper and print PCL, PostScript, scalable fonts, and HPGL (Hewlett-Packard Graphics Language), there is little that this printer can't do. Its generous 1500-sheet-capacity paper tray means you don't have to spend a lot of time swapping trays.

			BYTE PERFORMANCE SCORES (PPM) PC PCL	PC POSTSCRIPT	MAC OVERALL	QUALITY INDEX	CLASS (PPM)	PRICE	RESOLUTION (DPI)	MEMORY (MB) STAN., MAX.
BEST	Compaq PageMarq 20	▲	7.66	6.15	6.26	8.78	20 ppm	$5561	800	4, 20
RUNNER-UP	LaserMaster Unity 1200 XLT	▲	3.12	3.88	2.71	9.89	8 ppm	$6995	1200	21, 48
RUNNER-UP	Compaq PageMarq 15	▲	4.72	4.57	4.82	8.33	15 ppm	$2599	300	4, 18
RUNNER-UP	LaserMaster Unity 1200 XLO	▲	3.37	2.17	2.17	9.89	8 ppm	$8995	1200	32, 48
RUNNER-UP	Xante Accel-a-Writer 8100	▲	3.69	1.66	1.53	9.17	8 ppm	$3995	1200	12, 64

Budget-conscious?

LOW COST — **Compaq PageMarq 15**



At $2599, this is one of the best deals going for a tabloid-capable laser printer. Standard features include PostScript, PCL, and HPGL, and the printer can automatically sense the language being received. The PageMarq 15 has half the paper capacity (750 pages) and a slow speed of 4.7 ppm compared to the more expensive PageMarq 20.

			BYTE PERFORMANCE SCORES (PPM) PC PCL	PC POSTSCRIPT	MAC OVERALL	QUALITY INDEX	CLASS (PPM)	PRICE	RESOLUTION (DPI)	MEMORY (MB) STAN., MAX.
BEST	Compaq PageMarq 15	▲	4.72	4.57	4.82	8.33	15 ppm	$2599	300	4,18
RUNNER-UP	Xante Accel-a-Writer 8100	▲	3.69	1.66	1.53	9.17	8 ppm	$3995	1200	12, 64
RUNNER-UP	Genicom 7150	▲	3.66	3.45	3.63	8.89	15 ppm	$3345	400	4, 20
RUNNER-UP	DataProducts LZR 1560	▲	3.45	3.96	4.82	7.56	15 ppm	$3395	400	4, 16

For the best output...

HIGH QUALITY — **LaserMaster Unity 1200 XLT**



The Unity 1200 XLT produced the best output of all the 176 models we tested. However, at 1200 dpi, the printer scored a slow 3.88 ppm in our tests. It's clearly meant for typesetting: It comes with a 20-MB hard drive, 135 resident fonts, and 21 MB of memory.

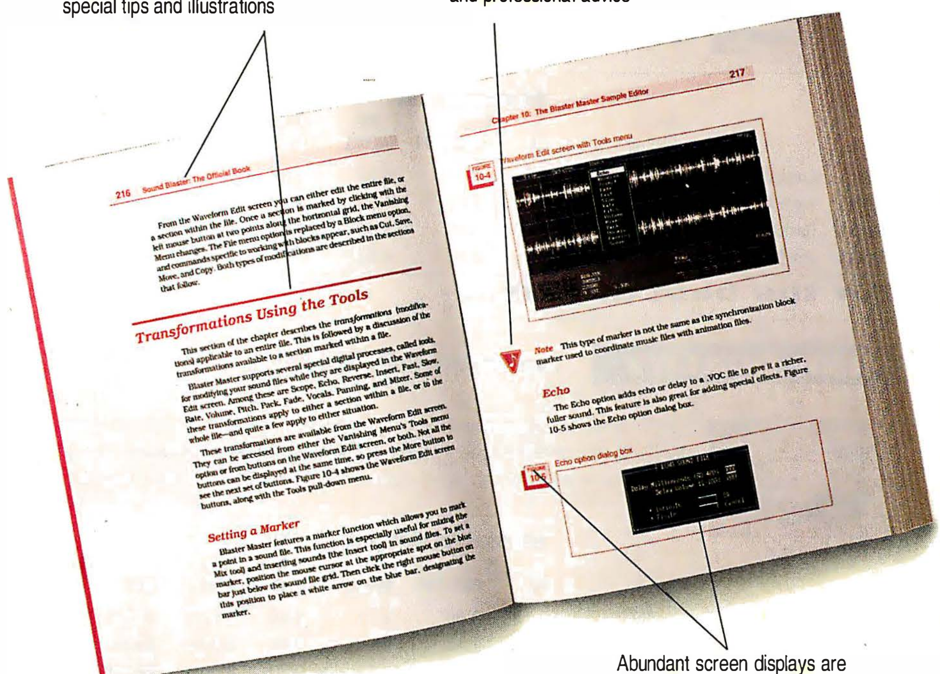
			BYTE PERFORMANCE SCORES (PPM) PC PCL	PC POSTSCRIPT	MAC OVERALL	QUALITY INDEX	CLASS (PPM)	PRICE	RESOLUTION (DPI)	MEMORY (MB) STAN., MAX.
BEST	LaserMaster Unity 1200 XLT	▲	3.12	3.88	2.71	9.89	8 ppm	$6995	1200	21, 48
RUNNER-UP	LaserMaster Unity 1200 XLO	▲	3.37	2.17	2.17	9.89	8 ppm	$8995	1200	32, 48
RUNNER-UP	GCC Select Press 600	▲	—	3.29	3.59	9.33	8 ppm	$4499	600	16, 16
RUNNER-UP	QMS 860 Print System	▲	—	3.48	3.54	9.11	8 ppm	$4595	600	12, 32
RUNNER-UP	Xante Accel-a-Writer 8100	▲	3.69	1.66	1.53	9.17	8 ppm	$3995	1200	12, 64

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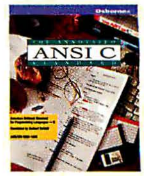
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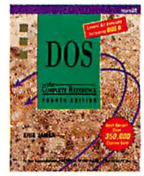
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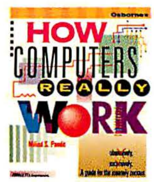
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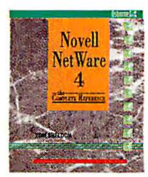
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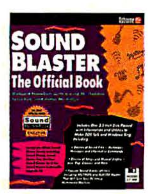
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BYTE BEST

PORTABLE

The nine portable printers we tested represented three different printing technologies. The dot-matrix models provided reasonably fast output and low price, but they almost always scored low on our quality tests. The thermal printers were fast and had much better quality than dot-matrix and ink-jet models, but their prices were almost double those of their competitors. Ink-jet printers tended to be slow, but they offered good quality and lower prices. If noise is a concern for you, the thermals and ink-jets were pleasantly quiet compared to the dot-matrix printers.

Picking a portable printer is an exercise in compromises: The perfect low-cost, lightweight, high-speed, high-quality printer doesn't exist. Overall, portable printers are slower and produce lower-quality output than their desktop counterparts.

The closest thing we found to our ideal portable printer was the Lexmark IBM 4070 IJ. This unit is one of just three printers to repeat as best overall from our May Lab Report.

The Mannesmann Tally MobileWriter PS won in our quality rankings hands down, but at $999 and 8.3 pounds, it may cost and weigh more than your notebook computer does. Its main advantage is its complete PostScript interpreter and 2 MB of RAM.

For Mac PowerBook users, the under-5-pound, $439 Apple Portable StyleWriter is our top choice. It comes standard with a battery that lasts for about 40 minutes. The printer supports Macs using the serial-to-parallel conversion cable.

KEY

▲ Laser ■ Ink-jet

● Dot-matrix ◆ Dye-sublimation

★ Thermal

For the best in speed...

BEST OVERALL Lexmark IBM 4070 IJ

NOVEMBER 1993 BYTE BEST PORTABLE PRINTER

Though not the fastest printer in this category, the 4070 IJ produces high-quality output from its 360-dpi print mechanism and comes in a compact and easily transportable package. Its retail price of $449 makes it the lowest-priced printer ranked for best overall.



			BYTE PERFORMANCE SCORES (PPM) PC DRAFT	PC POSTSCRIPT	MAC OVERALL	QUALITY INDEX	CLASS (PPM)	PRICE	RESOLUTION (DPI)	SIZE & WEIGHT (IN.)(W/O BATTERY)
BEST	Lexmark IBM 4070 IJ	■	1.93	—	—	6.22	110 cps	$449	360	2.1x12.4x8.7; 4
RUNNER-UP	Mannesmann Tally MobileWriter PS	★	3.59	1.01	1.38	6.58	6 ppm	$999	300	11.4x8.7x2.3; 8.3
RUNNER-UP	Mannesmann Tally MobileWriter	★	3.17	—	—	6.24	6 ppm	$875	300	11.4x8.7x2.3; 8.3

If $500 is your limit...

LOW COST Tandy DMP 310 slimline



At $200, no other portable costs less. This dot-matrix printer achieved average performance and quality ratings in our tests. You can stack up to 30 single sheets of paper in the paper cassette.

			BYTE PERFORMANCE SCORES (PPM) PC DRAFT	PC POSTSCRIPT	MAC OVERALL	QUALITY INDEX	CLASS (PPM)	PRICE	RESOLUTION (DPI)	SIZE & WEIGHT (IN.)(W/O BATTERY)
BEST	Tandy DMP 310 slimline	●	0.92	—	—	4.00	120 cps	$200	360	14.5x11.25x2.25; 5.9
RUNNER-UP	Seikosha LT20	■	0.80	—	—	2.00	180 cps	$499	360	14.6x11.3x2.0; 4

The best PowerBook companion...

MACINTOSH Apple Portable StyleWriter

This small, thin printer weighs about 4.5 pounds and lasts for about 40 minutes of use on a single charge. The printer supports the Mac line of computers using the included serial-to-parallel conversion cable. It has a print resolution of 360 dpi and provides average output quality for a portable ink-jet printer. Mannesmann Tally's alternative for Mac users achieves substantially faster speed and higher quality at more than double the cost.

			BYTE PERFORMANCE SCORES (PPM) PC DRAFT	PC POSTSCRIPT	MAC OVERALL	QUALITY INDEX	CLASS (PPM)	PRICE	RESOLUTION (DPI)	SIZE & WEIGHT (IN.)(W/O BATTERY)
BEST	Apple Portable StyleWriter	■	—	—	0.69	4.81	3 ppm	$439	360	12.2x8.7x1.9; 4.5
RUNNER-UP	Mannesmann Tally MobileWriter PS	★	3.59	1.01	1.38	6.58	6 ppm	$999	300	11.4x8.7x2.3; 8.3

Need sharp text for the road?

HIGH QUALITY Mannesmann Tally MobileWriter PS



At 300 dpi, the thermal-transfer MobileWriter PS produced the highest-quality output of any portable. At 8.3 pounds and with a price of $999, it is the heaviest and priciest portable in its class.

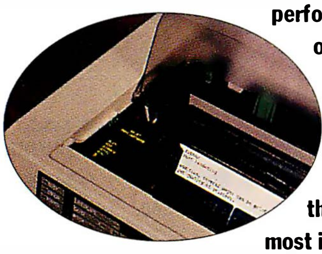
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BEST	Mannesmann Tally MobileWriter PS	★	3.59	1.01	1.38	6.58	6 ppm	$999	300	11.4x8.7x2.3; 8.3
RUNNER-UP	Lexmark IBM 4070 IJ	■	1.93	—	—	6.22	110 cps	$449	360	2.1x12.4x8.7;4
RUNNER-UP	Star Micronics StarJet SJ-48 Plus	■	0.80	—	—	5.94	124 cps	$369	360	12.2x8.5x1.9; 4.0
RUNNER-UP	Brother HJ-100 i	■	0.93	—	—	5.89	80 cps	$399	360	8.5x12.25x1.9;4

HONORABLE MENTIONS



The Lexmark IBM 4039Laser series are among the easiest-to-use printers on the market. The front-panel LCD displays error messages in plain English rather than in cryptic codes. The driver setup is smart enough to load for existing applications. The standard flash ROM lets you download fonts that remain in the printer after it's powered down. And the printer uses only 24 W when in idle or power-saver mode.

The C-Tech Speedjet 300 and its twin, the TI MicroMarc, achieve ink-jet price and quality with performance previously achieved only by dot-matrix and laser printers. The Speedjet has a wide print head that can print two lines of text at a time, so it can make just half the number of passes made by most ink-jet printers. The Speedjet is also notable for its unique paper-handling mechanism: We didn't encounter the jams and misfeeds we are accustomed to with low-cost ink-jets.



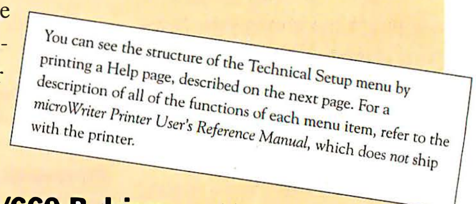
Kyocera is making innovations in the area of toner consumption: The cartridge in the Ecosys series never requires replacement. The Ecosys FS-1500A and Ecosys FS-3500A use a microfine ceramic toner that continuously cleans, polishes, and reconstructs the print drum while the printer is being used. You replenish the toner every 6000 pages by refilling the Ecoline cartridge. Since the toner cartridge assembly is constructed to last for the life of the printer, the result is fewer discarded cartridges to take up landfill space. If a cartridge fails, you can incinerate it; when the cartridge burns, it releases only water vapor and carbon dioxide, so there are no noxious chemicals added to the air.

Several printers achieve excellent 600-dpi resolution, but only the GCC Select Press 600 gives you 600-dpi tabloid prints that go right up to the edge of the page. All the other 600-dpi printers leave an unprintable region around the outside edge of the page that can measure a quarter of an inch or more. For proofing print runs, the full-bleed capability of the Select Press 600 is a more accurate match to the final-press capabilities.

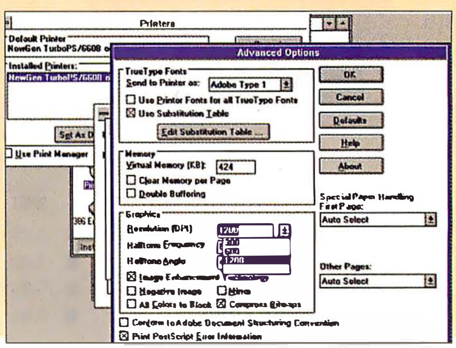


Dubious Achievements

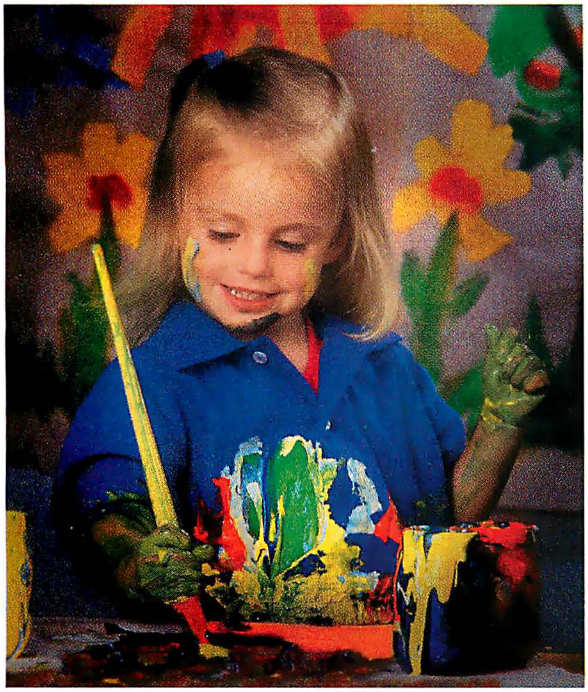
TI is the first printer vendor we have seen that makes basic documentation "optional." Although this seems like a viable alternative for a large corporate account with an in-house help desk, it's unfair to individuals who need to troubleshoot problems.


You can see the structure of the Technical Setup menu by printing a Help page, described on the next page. For a description of all of the functions of each menu item, refer to the *microWriter Printer User's Reference Manual*, which does not ship with the printer.

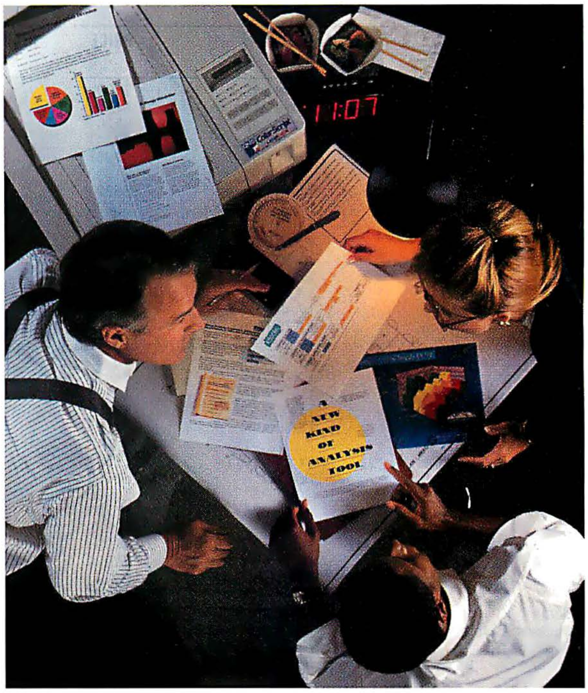
The NewGen Turbo PS/660 B driver provides you with an option for 1200-dpi printing, but it's just a tease—if you select 1200 dpi, the printer won't operate. You must select 600 dpi for correct operation.



June 14, 1963.
Cindy Smith plays with color.



Thirty years later her business depends on it.



Introducing the QMS ColorScript Laser 1000. Now your business has total freedom of expression.

For Cindy, communicating decision-critical information quickly, flawlessly and in brilliant color is now her livelihood. That's why she depends on the QMS ColorScript® Laser 1000 Print System. It frees her to print entire forms and letterhead with color logos, images and high quality text without changing paper. It saves her the cost of stocking special forms, letterhead and multiple sets of supplies and uses standard paper and transparencies. It improves her message by highlighting key data with color in multipage presentations and documents. Add direct connection to a variety of networks and anyone can realize both greater productivity and a per user cost that rivals personal printers. Plus, our easy software loadable upgrades virtually eliminate obsolescence.

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• Laser color and monochrome printing • Compatibility with PostScript™ Level 2 and Level 1, HP PCL®5C and HP-GL® • TrueType font scaling • Automatic collation • Simultaneous input and automatic emulation switching • 65 resident type fonts • EfiColor™ and Colorimetric color dictionaries and Apple ColorSync™ device profile • Supports DOS, Windows,™ Macintosh® and Unix® applications • Software loadable system upgrades



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Circle 101 on Inquiry Card (RESELLERS: 102).

DOT-MATRIX

	MODEL	PRICE	Monochrome Performance: HIGH-QUALITY	DRAFT	POSTSCRIPT	MAC	QUALITY	Class: PPM	CPS	DPI
Advanced Matrix Technology, Inc.	Accel-212	$469	0.81	1.96	—	—	2.89	—	240	240
Advanced Matrix Technology, Inc.	Accel-212d	$764	0.93	1.91	—	—	2.28	—	240	240
Advanced Matrix Technology, Inc.	Accel-242	$529	0.45	0.94	—	—	4.11	—	240	360
Advanced Matrix Technology, Inc.	Accel-242d	$824	1.20	1.62	—	—	4.28	—	240	360
Advanced Matrix Technology, Inc.	Accel-292	$795	0.91	0.85	—	—	2.72	—	540	240
Advanced Matrix Technology, Inc.	Accel-292d	$1090	0.91	1.48	—	—	3.61	—	540	240
Advanced Matrix Technology, Inc.	Accel-214	$529	0.93	2.66	—	—	3.00	—	240	240
Brother International Corp.	M1324	$399	1.10	1.47	—	—	3.56	—	216	360
C-Tech Electronics, Inc.	C-610 II	$799	1.00	1.77	—	—	2.83	—	300	360
C-Tech Electronics, Inc.	ProWriter C-310P	$739	0.64	1.05	—	—	2.22	—	250	144
DataSouth Computer	XL300DD	$1795	1.15	2.66	—	—	2.44	—	300	240
Decision Data	6520 Model 41	$460	1.46	3.37	—	—	3.22	—	320	144
Digital Equipment Corp.	LA 310	$599	1.07	3.03	—	—	2.78	—	300	180
Digital Equipment Corp.	LA 424	$1249	0.83	1.13	—	—	3.22	—	400	360
Digital Equipment Corp.	LA75 Plus	$549	0.65	0.85	—	—	3.33	—	250	360
Epson America, Inc.	Action Printer 3250	$269	0.18	0.78	—	—	4.44	—	240	360
Epson America, Inc.	AP-5000+	$349	0.87	2.70	—	—	4.28	—	269	360
Epson America, Inc.	FX-1170	$499	1.17	2.01	—	—	2.78	—	380	240
Epson America, Inc.	LQ-1170	$859	1.09	3.27	—	—	4.33	—	415	360
Epson America, Inc.	LQ-870	$629	0.45	1.91	—	—	4.39	—	315	360
Fujitsu Computer Products of America	DL5800	$1595	2.14	3.06	—	—	3.67	—	420	360
GCC Technologies, Inc.	WriteImpact	$599	—	—	—	0.53	1.11	—	192	360
Genicom Corp.	3840EP	$2595	1.48	4.38	—	—	2.06	—	600	400
Genicom Corp.	3940IP	$3995	1.45	1.54	—	—	2.33	—	600	400
Lexmark International, Inc.	IBM 4226	$1799	1.20	2.13	—	—	3.00	—	533	240
Mannesmann Tally Corp.	**MT 360**	**$2695**	**2.73**	**5.53**	**—**	**—**	**3.67**	**—**	**600**	**360**
NEC Technologies, Inc.	Pinwriter P6200	$499	0.93	2.24	—	—	4.56	—	250	360
Okidata	Pacemark 3410	$1999	1.88	4.99	—	—	2.56	—	550	216
Okidata	Microline 380	$349	0.87	0.90	—	—	3.00	—	240	180
Okidata	Microline 395	$1499	1.47	2.53	—	—	3.89	—	607	360
Okidata	Microline 521	$799	1.43	2.03	—	—	2.56	—	430	288
Panasonic Communications & Systems Co.	KXP-2624	$480	1.08	2.33	—	—	3.67	—	300	360
Samsung Electronics America, Inc.	SP-2412	$299	0.83	1.00	—	—	2.78	—	240	360
Seikosha America, Inc.	SL270	$999	1.23	2.71	—	—	2.11	—	329	360
Seikosha America, Inc.	SP2400	$299	0.71	1.49	—	—	2.78	—	300	240
Star Micronics America, Inc.	NX-2450 Rainbow	$289	0.86	1.08	—	—	3.78	—	240	360
Star Micronics America, Inc.	NX-2480 Rainbow	$329	0.64	—	—	—	4.56	—	330	360
Tandy Corp.	DMP 250	$400	0.83	1.96	—	—	4.50	—	200	360

INK-JET

	MODEL	PRICE	HIGH-QUALITY	DRAFT	POSTSCRIPT	MAC	QUALITY	PPM	CPS	DPI
Apple Computer, Inc.	StyleWriter II	$359	—	—	—	1.77	5.11	2	—	360
Brother International Corp.	HJ 400	$419	1.06	2.67	—	1.23	5.00	—	110	360
C-Tech Electronics, Inc.	**Speedjet 300**	**$419**	**2.18**	**2.23**	**—**	**—**	**4.67**	**—**	**300**	**300**
Canon Computer Systems, Inc.	BJ-230	$549	1.73	2.71	—	—	4.56	—	173	360
Canon Computer Systems, Inc.	BJ-200	$399	1.27	2.16	—	1.18	4.06	—	248	360
Digital Equipment Corp.	DEC MultiJet 2000	$449	1.12	1.95	—	1.11	2.89	—	360	300
Epson America, Inc.	Stylus 800	$449	1.46	1.50	—	—	5.00	—	150	360
GCC Technologies, Inc.	Wide Writer 360	$1699	—	1.46	—	1.61	4.78	—	300	360
Hewlett-Packard Co.	DeskJet 500	$365	1.62	2.15	—	1.61	3.39	—	240	300
Lexmark International, Inc.	IBM ExecJet 4072	$799	0.39	0.43	—	0.35	4.39	—	300	360
Olivetti	CJP-450	$499	1.04	1.64	—	0.70	2.44	—	160	300
Pacific Data Products	ProTracerII/GL	$2149	—	0.97	—	—	2.67	—	150	360
Smith Corona Corp.	Coronajet 200j	$499	1.07	1.72	—	0.82	2.89	—	160	800
Texas Instruments, Inc.	MicroMarc	$369	2.16	2.27	—	—	4.28	—	300	300

LASER

	MODEL	PRICE	HIGH-QUALITY	DRAFT	POSTSCRIPT	MAC	QUALITY	PPM	CPS	DPI
Advanced Matrix Technology, Inc.	Tracjet Model III	$6995	—	6.41	7.35	—	5.44	16	—	300
Alps America	LSX1600	$3295	—	5.88	—	—	6.67	16	—	300
Apple Computer, Inc.	LaserWriter 310	$1099	—	—	1.42	1.78	7.72	—	—	300
Apple Computer, Inc.	LaserWriter IIf	$1015	—	—	—	3.80	5.44	8	—	300
Apple Computer, Inc.	LaserWriter IIg	$2309	—	—	—	4.01	6.00	8	—	300
Apple Computer, Inc.	LaserWriter NTR	$1179	—	—	—	2.23	6.11	4	—	300
Apple Computer, Inc.	LaserWriter Pro 630	$2529	—	3.17	2.88	3.80	9.11	8	—	600
Brother International Corp.	HL 10H	$1549	—	5.00	4.61	—	8.56	10	—	600
Brother International Corp.	HL 6	$895	—	3.84	—	—	6.67	6	—	300
Brother International Corp.	HL10 PS	$2395	5.00	4.55	2.97	—	5.78	10	—	300
C-Tech Electronics, Inc.	Prowriter CI-8E	$1695	—	4.57	—	—	5.44	8	—	300
C-Tech Electronics, Inc.	Prowriter CI-8	$2395	—	4.44	2.50	—	7.22	8	—	300
Compaq Computer Corp.	**PageMarq 20**	**$5561**	**5.79**	**7.66**	**6.15**	**6.26**	**8.78**	**20**	**—**	**800**
Compaq Computer Corp.	PageMarq 15	$2599	—	4.72	4.57	4.82	8.33	15	—	300; w/PS 800x400
DataProducts Corp.	LZR 1560	$3395	—	3.45	3.96	4.82	7.56	15	—	300 or 400
DataProducts Corp.	LZR 965	$2199	—	3.37	3.10	3.84	7.56	9	—	600
Digital Equipment Corp.	DECLaser 1152	$999	—	1.30	1.24	1.73	5.89	4	—	300
Decision Data	6010 SI	$3995	—	3.31	—	—	4.22	10	—	300
Epson America, Inc.	ActionLaser 1000	$799	—	4.51	—	—	5.11	6	—	300
Epson America, Inc.	ActionLaser 1500	$999	—	4.17	—	—	8.22	6	—	300
Fujitsu Computer Products of America	Print Partner 10W	$2450	—	5.73	4.03	4.00	6.22	10	—	300
GCC Technologies, Inc.	BLP Eclipse 4	$1099	—	—	1.99	1.92	8.39	4	—	300
GCC Technologies, Inc.	BLP Eclipse 8	$1799	—	—	2.83	2.49	8.06	8	—	300
GCC Technologies, Inc.	Select Press 600	$4499	—	—	3.29	3.59	9.33	8	—	600
Genicom Corp.	7150	$3345	—	3.66	3.45	3.63	8.89	15	—	400
Genicom Corp.	7170	$3725	—	4.04	3.59	—	6.56	17	—	300
Hewlett-Packard Co.	LaserJet 4	$1759	4.17	4.85	—	—	8.33	8	—	600
Hewlett-Packard Co.	LaserJet 4L	$849	—	2.74	—	—	5.44	4	—	300
Hewlett-Packard Co.	LaserJet 4M	$2399	3.59	4.85	3.21	3.95	8.78	8	—	600
Hewlett-Packard Co.	LaserJet 4ML	$1279	—	3.08	2.46	2.68	8.33	4	—	300
Hewlett-Packard Co.	LaserJet 4P	$1229	2.38	2.38	—	—	8.44	6	—	600
Hewlett-Packard Co.	LaserJet 4Si	$3749	8.14	9.65	—	—	8.67	17	—	600
Hewlett-Packard Co.	**LaserJet 4SiMx**	**$5499**	**—**	**1.94**	**1.77**	**1.38**	**8.72**	**17**	**—**	**600**
Kyocera Electronics, Inc.	Ecosys FS-1500A	$2395	—	3.39	—	—	5.94	10	—	300
Kyocera Electronics, Inc.	Ecosys FS-3500A	$3895	—	6.34	5.97	—	6.33	18	—	300
LaserMaster Corp.	Unity 1200 XLO	$8995	—	3.37	2.17	2.17	9.89	8	—	1200
LaserMaster Corp.	Unity 1200 XLT	$6995	—	3.12	3.88	2.71	9.89	8	—	1200
Lexmark International, Inc.	IBM 4039Laser 10R	$1599	4.88	7.04	3.12	4.32	9.00	10	—	600
Lexmark International, Inc.	IBM 4039Laser 12L	$2899	6.62	8.68	3.55	5.00	8.81	12	—	600
Lexmark International, Inc.	**IBM 4039Laser 12R**	**$1999**	**2.82**	**8.63**	**3.57**	**5.04**	**8.74**	**12**	**—**	**600**
Lexmark International, Inc.	IBM 4039Laser 16L	$3399	6.96	11.37	3.71	5.67	8.44	16	—	600
Mannesmann Tally Corp.	MT 908	$1499	—	4.56	2.49	—	6.56	8	—	300
NEC Technologies, Inc.	Silentwriter 95	$949	—	3.54	1.40	1.91	7.44	6	—	300
NEC Technologies, Inc.	Silentwriter Superscript 610	$700	—	4.55	—	—	6.67	6	—	300

= BYTE Best. ● = Yes ○ = No

Emulations

HP DESKJET 500/500C/550C	POSTSCRIPT	PCL5 (HP LJIII)	PCL4 (HP LJ 4)	HPGL	EPSON LQ/FX	IBM PROPRINTER	IBM GRAPHICS	TOLL-FREE	PHONE	INQUIRY NO.
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○	○	○	○	○	○	●	●	(800) 992-2264	(805) 388-5799	1106
○	○	○	○	○	○	●	●	(800) 992-2264	(805) 388-5799	1107
○	○	○	○	○	○	●	●	(800) 992-2264	(805) 388-5799	1108
○	○	○	○	○	○	●	●	(800) 992-2264	(805) 388-5799	1109
○	○	○	○	○	○	●	●	(800) 992-2264	(805) 388-5799	1110
○	○	○	○	○	●	●	●	(800) 992-2264	(805) 388-5799	1111
○	○	○	○	○	○	●	○	(800) 276-7746	(908) 356-8880	1112
○	○	○	○	○	●	●	○	(800) 347-4017	(714) 833-1165	1113
○	○	○	○	○	○	○	○	(800) 347-4017	(714) 833-1165	1114
○	○	○	○	○	●	○	○	(800) 476-2120	(704) 523-8500	1115
○	○	○	○	○	○	●	○	(800) 533-3282	(215) 956-6700	1116
○	○	○	○	○	●	●	○	(800) 344-4825	(508) 493-5111	1251
○	○	○	○	○	○	●	○	(800) 344-4825	(508) 493-5111	1117
○	○	○	○	○	○	●	○	(800) 344-4825	(508) 493-5111	1118
○	○	○	○	○	●	○	●	(800) 289-3776	(310) 782-0770	1119
○	○	○	○	○	●	○	●	(800) 289-3776	(310) 782-0770	1120
○	○	○	○	○	●	●	●	(800) 289-3776	(310) 782-0770	1121
○	○	○	○	○	●	○	●	(800) 289-3776	(310) 782-0770	1122
○	○	○	○	○	●	○	●	(800) 289-3776	(310) 782-0770	1123
○	○	○	○	○	●	●	○	(800) 826-6112	(408) 432-6333	1124
○	○	○	○	○	○	○	○	(800) 942-3233	(617) 275-5800	1125
○	○	○	○	○	○	●	●	(800) 443-6426	(703) 802-9200	1126
○	○	○	○	○	○	○	○	(800) 443-6426	(703) 802-9200	1127
○	○	○	○	○	●	●	○	(800) 426-2486	(606) 232-3000	1128
○	○	○	○	○	●	●	●	(800) 843-1347	(206) 251-5500	1129
○	○	○	○	○	○	○	○	(800) 632-4636	(508) 264-8000	1130
○	○	○	○	○	●	●	○	(800) 654-3282	(609) 235-2600	1346
○	○	○	○	○	●	○	○	(800) 654-3282	(609) 235-2600	1347
○	○	○	○	○	●	●	○	(800) 654-3282	(609) 235-2600	1348
○	○	○	○	○	●	●	○	(800) 654-3282	(609) 235-2600	1349
○	○	○	○	○	●	●	○	(800) 742-8086	(201) 348-7000	1350
○	○	○	○	○	○	●	○	(800) 446-0262	(201) 229-4000	1351
○	○	○	○	○	●	●	○	(800) 477-7468	(702) 827-2414	1352
○	○	○	○	○	●	●	●	(800) 477-7468	(702) 827-2414	1353
○	○	○	○	○	●	●	○	(800) 477-4700	(908) 572-3300	1354
○	○	○	○	○	●	●	○	(800) 447-4700	(908) 572-3300	1355
○	○	○	○	○	○	●	○	N/A	(817) 390-3011	1356
○	○	○	○	○	○	○	○	(800) 776-2333	(408) 996-1010	1357
○	○	○	○	○	●	●	●	(800) 276-7746	(908) 356-8880	1358
●	○	○	○	○	○	○	○	(800) 347-4017	(714) 833-1165	1359
○	○	○	○	○	●	●	○	(800) 848-4123	(714) 438-3000	1360
○	○	○	○	○	●	●	○	(800) 848-4123	(714) 438-3000	1361
●	○	○	○	○	●	●	○	(800) 344-4825	(508) 493-5111	1362
●	○	○	○	○	●	Opt.	○	(800) 289-3776	(310) 782-0770	1363
○	○	○	○	○	○	○	○	(800) 942-3233	(617) 275-5800	1364
●	○	○	○	○	○	○	○	(800) 752-0900	(208) 323-2551	1365
○	Level I	○	○	○	●	●	●	(800) 426-2468	(606) 232-3000	1366
●	○	○	○	○	Opt.	Opt.	○	(800) 633-9909	(509) 927-7052	1367
○	Level I opt.	○	○	●	●	●	○	N/A	(619) 625-3663	1368
●	○	○	○	○	●	●	○	(800) 448-1018	(203) 972-1471	1369
●	○	○	○	○	○	○	○	(800) 527-3500	(817) 774-6001	1370
○	Level I opt.	●	●	●	○	Opt.	Opt.	(800) 992-2264	(805) 388-5799	1371
○	Level I opt.	○	●	○	○	○	○	(800) 825-2577	(408) 432-6000	1372
○	Level I	○	○	○	○	○	○	(800) 776-2333	(408) 996-1010	1373
○	Level II	○	Opt.	○	○	○	○	(800) 776-2333	(408) 996-1010	1374
○	Level II	○	Opt.	○	○	○	○	(800) 776-2333	(408) 996-1010	1375
○	Level I, II	○	●	○	○	○	○	(800) 776-2333	(408) 996-1010	1376
○	Level II	○	Opt.	○	○	○	○	(800) 776-2333	(408) 996-1010	1377
○	Level I	●	●	●	●	●	●	(800) 276-7746	(908) 356-8880	1378
○	Level I opt.	○	●	○	●	●	○	(800) 276-7746	(908) 356-8880	1379
○	Level I	○	●	Opt.	Opt.	Opt.	○	(800) 276-7746	(908) 356-8880	1380
○	○	●	○	●	●	●	○	(800) 347-4017	(714) 833-1165	1381
○	Level I	●	○	●	●	●	○	(800) 347-4017	(714) 833-1165	1382
○	Level II	●	○	●	○	○	●	(800) 345-1518	(713) 370-0670	1383
○	Level II	●	○	●	○	○	○	(800) 345-1518	(713) 370-0670	1384
○	Level II	○	●	○	○	○	○	(800) 334-3174	(818) 887-8000	1385
○	Level II	○	●	○	○	○	○	(800) 334-3174	(818) 887-8000	1386
○	Level II	○	●	○	○	○	○	(800) 344-4825	(508) 493-5111	1252
○	○	○	●	○	○	○	○	(800) 533-3282	(215) 956-6700	1387
○	○	○	●	○	●	○	○	(800) 289-3776	(310) 782-0770	1388
○	Level I opt.	●	●	●	●	○	○	(800) 289-3776	(310) 782-0770	1389
○	Level I	●	●	●	●	●	○	(800) 826-6112	(408) 432-6333	1390
○	Level I, II	○	○	○	○	○	○	(800) 942-3233	(617) 275-5800	1391
○	Level I, II	○	○	○	○	○	○	(800) 942-3233	(617) 275-5800	1392
○	Level I, II	●	○	●	○	○	○	(800) 942-3233	(617) 275-5800	1393
○	Level I	●	○	●	○	○	○	(800) 443-6426	(703) 802-9200	1394
○	Level I opt.	●	●	●	○	●	○	(800) 443-6426	(703) 802-9200	1395
○	Level II opt.	●	○	○	Opt.	Opt.	○	(800) 752-0900	(208) 323-2551	1253
○	○	●	○	○	○	○	○	(800) 752-0900	(208) 323-2551	1254
○	Level I, II	●	○	●	Opt.	Opt.	○	(800) 752-0900	(208) 323-2551	1396
○	Level I, II	●	○	●	○	○	○	(800) 752-0900	(208) 323-2551	1397
○	Level II opt.	●	○	●	Opt.	Opt.	○	(800) 752-0900	(208) 323-2551	1398
○	Level II opt.	●	○	●	Opt.	Opt.	○	(800) 752-0900	(208) 323-2551	1399
○	Level II	●	○	●	Opt.	Opt.	○	(800) 752-0900	(208) 323-2551	1400
○	Level I	●	○	●	●	●	○	(800) 367-7437	(908) 560-3400	1401
○	Level I opt.	●	○	●	●	●	○	(800) 367-7437	(908) 560-3400	1402
○	Level I	○	●	○	○	○	○	N/A	(612) 944-7570	1403
○	Level I	○	●	○	○	○	○	N/A	(612) 944-7570	1404
○	Level I	●	●	○	○	○	○	(800) 426-2468	(606) 232-3000	1405
○	Level I	●	●	○	○	○	○	(800) 426-2468	(606) 232-3000	1406
○	Level I	●	●	○	○	○	○	(800) 426-2468	(606) 232-3000	1407
○	Level I	●	●	○	○	○	○	(800) 426-2468	(606) 232-3000	1408
○	Level I opt.	●	●	●	●	●	○	(800) 843-1347	(206) 251-5500	1409
○	Level I	●	○	○	○	○	○	(800) 632-4636	(508) 264-8000	1410
○	○	●	○	○	○	○	○	(800) 632-4636	(508) 264-8000	1411

ROLL CALL

LASER

	MODEL	PRICE	Performance: HIGH-QUALITY	Performance: DRAFT	Performance: POSTSCRIPT	Performance: MAC	QUALITY	Class: PPM	Class: CPS	DPI
NewGen Systems Corp.	ImagerPlus 12	$7495	—	—[2]	—[2]	1.33	9.44	8	—	1200
NewGen Systems Corp.	Turbo PS/660 p	$1995	—	1.85	2.02	1.98	9.17	4	—	600
NewGen Systems Corp.	Turbo PS/660 B	$4995	—	—[2]	2.06	2.14	9.17	8	—	600
Okidata	OL-810	$1499	—	5.59	—	—	5.33	8	—	300
Okidata	OL-400E	$699	—	3.46	—	—	6.44	4	—	300
Okidata	OL-830+	$1799	—	4.32	1.27	—	5.22	8	—	300
Okidata	OL-850	$1999	—	5.04	1.26	2.05	7.56	8	—	300
Panasonic Communications & Systems Co.	KXP-4430	$869	—	2.59	—	—	5.22	5	—	300
Panasonic Communications & Systems Co.	KXP-4455	$2249	—	2.86	1.26	1.99	5.78	11	—	300
QMS, Inc.	1725 Print System	$4999	—	6.49	3.51	4.05	8.44	17	—	600
QMS, Inc.	PS 410	$1595	—	2.03	2.17	1.97	5.56	4	—	300
QMS, Inc.	860 Print System	$4595	—	—	3.48	3.54	9.11	8	—	600
QMS, Inc.	420 Print System	$1995	—	1.92	1.90	2.42	7.61	4	—	600
Samsung Electronics America, Inc.	Finale Hi-Res	$2395	—	5.25	1.93	2.69	6.00	8	—	1200
Sharp Electronics Corp.	JX-9400	$695	—	2.22	—	—	6.22	6	—	300
Star Micronics America, Inc.	LS-5TT	$1289	—	3.27	1.12	1.29	6.00	5	—	600
Tandy Corp.	LP800	$1499	—	4.94	1.16	—	6.11	8	—	300
Texas Instruments, Inc.	MicroLaser Pro 600	$1599	—	—	2.66	3.83	8.72	8	—	600
Texas Instruments, Inc.	MicroLaser Pro 600[1]	$1948	—	3.98	5.37	5.23	9.72	8	—	600
Texas Instruments, Inc.	MicroWriter PS23	$799	—	2.94	1.19	1.80	8.00	5	—	300
Texas Instruments, Inc.	MicroWriter PS65	$1099	—	2.98	1.19	1.80	6.33	5	—	300
Texas Instruments, Inc.	MicroLaser PS35	$810	—	3.86	—	2.13	5.89	9	—	300
Texas Instruments, Inc.	MicroLaser PS35 Turbo	$1068	—	4.27	3.64	3.99	5.78	9	—	300
Texas Instruments, Inc.	MicroLaser XL	$2399	—	5.19	1.38	2.13	5.44	16	—	300
Texas Instruments, Inc.	MicroLaser XL Turbo	$3649	—	5.55	4.32	3.99	5.78	16	—	300
Toshiba America Information Systems	Pagelaser GX200	$3096	—	4.55	1.34	—	8.11	8	—	300
Toshiba America Information Systems	Pagelaser GX400	$5996	—	5.99	2.55	—	6.22	17	—	300
Xante Corp.	Accel-a-Writer 4000	$1795	—	3.04	1.87	1.94	8.44	4	—	600
Xante Corp.	Accel-a-Writer 8000	$2295	—	5.18	2.67	2.78	8.44	8	—	600
Xante Corp.	Accel-a-Writer 8100	$3995	—	3.69	1.66	1.53	9.17	8	—	1200
Xerox Corp.	4213	$4995	—	5.57	2.20	2.91	5.56	13	—	300

PORTABLE

	MODEL	TECHNOLOGY	PRICE	Performance: HIGH-QUALITY	Performance: DRAFT	Performance: MAC	QUALITY	Class: PPM	Class: CPS	DPI
Apple Computer, Inc.	Portable StyleWriter	Ink-jet	$439	—	—	0.69	4.81	1.5 ppm	3 ppm	360
Axonix Corp.	MilWrite LVD	Dot-matrix	$1395	0.74	1.47	—	2.28	—	300	240
Brother International Corp.	HJ-100i	Ink-jet	$399	0.92	0.93	—	5.89	—	80	360
Canon Computer Systems, Inc.	BJ-10ex	Ink-jet	$349	0.90	0.93	—	5.36	—	83	360
Citizen America Corp.	PN48 Professional	Thermal	$549	0.42	0.55	—	3.81	—	—	360
Eastman Kodak Co.	Diconix 701	Ink-jet	$479	1.00	1.45	—	4.11	—	3 ppm	300
Hewlett-Packard Co.	DeskJet Portable	Ink-jet	$479	1.93	1.45	—	4.67	—	240	300
Lexmark International, Inc.	IBM Portable Printer	Thermal	$449	0.44	0.63	—	3.76	—	—	360
Lexmark International, Inc.	**IBM 4070 IJ**	**Ink-jet**	**$449**	**1.71**	**1.93**	**—**	**6.22**	**—**	**110**	**360**
Mannesmann Tally Corp.	MobileWriter	Thermal	$875	2.45	3.17	—	6.24	6.00	—	300
Mannesmann Tally Corp.	MobileWriter PS	Thermal	$999	1.01 (PostScript)	3.59	1.38	6.58	6.00	—	300
Seikosha America, Inc.	LT20	Dot-matrix	$499	0.73	0.80	—	2.00	—	180	360
Star Micronics America, Inc.	StarJet SJ-48 Plus	Ink-jet	$369	0.73	0.80	—	5.94	—	124	360
Tandy Corp.	DMP 310 slimline	Dot-matrix	$200	0.73	0.92	—	4.00	—	120	360

COLOR

	MODEL	TECHNOLOGY	PRICE	Performance: PC MONO	Performance: MAC MONO	Performance: HIGH-QUALITY COLOR	Performance: DRAFT COLOR	Performance: POSTSCRIPT COLOR	Performance: MAC COLOR
Advanced Matrix Technology, Inc.	Accel-535	Dot-matrix	$1485	0.83	—	0.16	0.24	—	—
Alps America	DMX800	Dot-matrix	$2195	1.90	—	0.46	0.55	—	—
Apple Computer, Inc.	ColorPrinter	Ink-jet	$1659	—	0.89	—	—	—	0.73
Brother International Corp.	M1824L	Dot-matrix	$749	0.74	—	0.13	0.36	—	—
Calcomp	ColorMaster Plus 6613XF	Thermal	$8995	—	0.97	—	—	0.59	0.87
Canon Computer Systems, Inc.	BJC-800	Ink-jet	$1999	0.48	—	0.28	0.68	—	—
Citizen America Corp.	GSX-190	Dot-matrix	$199	0.87	—	0.23	0.55	—	—
Citizen America Corp.	GSX-230	Dot-matrix	$299	0.82	—	0.18	0.36	—	—
Citizen America Corp.	GSX-240	Dot-matrix	$349	0.97	—	0.22	0.39	—	—
DataProducts Corp.	9044	Dot-matrix	$1132	0.72	—	0.18	0.26	—	—
DataProducts Corp.	Jolt PSe	Solid ink	$4995	—	1.08	—	—	0.19	0.35
Digital Equipment Corp.	LA 95-DECWRITER	Dot-matrix	$319	1.27	—	0.42	0.57	—	—
Eastman Kodak Co.	Colorease PS	Dye-sub.	$7999	—	0.24	—	—	0.16	0.18
Fujitsu Computer Products of America	DL1200	Dot-matrix	$649	0.87	—	0.18	0.35	—	—
General Parametrics	**Spectra Star GT**	**Thermal**	**$4495**	**—**	**1.50**	**—**	**—**	**1.02**	**0.93**
General Parametrics	Spectra Star Q10E	Thermal	$2999	—	0.77	—	—	0.31	0.68
Hewlett-Packard Co.	DeskJet 1200C	Ink-jet	$1699	—	1.38	—	0.72	—	0.69
Hewlett-Packard Co.	**DeskJet 1200C/PS**	**Ink-jet**	**$2399**	**—**	**1.38**	**—**	**0.72**	**0.34**	**0.69**
Hewlett-Packard Co.	DeskJet 550C	Ink-jet	$719	0.69	—	0.18	0.61	—	—
Hewlett-Packard Co.	PaintJet XL300	Ink-jet	$2795	—	0.35	—	0.27	0.12	0.18
Lexmark International, Inc.	IBM Color JetPrinter PS4079	Ink-jet	$3199	—	0.70	—	—	0.24	0.41
Mannesmann Tally Corp.	MT 150/9C	Dot-matrix	$799	1.17	—	0.45	0.44	—	—
Okidata	Microline 590	Dot-matrix	$699	1.92	—	0.40	0.62	—	—
Panasonic Communications & Systems Co.	KXP-2123	Dot-matrix	$300	0.49	—	0.21	0.47	—	—
Panasonic Communications & Systems Co.	KXP-2124	Dot-matrix	$370	0.49	—	0.18	0.47	—	—
Panasonic Communications & Systems Co.	KXP-2180	Dot-matrix	$200	0.60	—	0.20	0.39	—	—
QMS, Inc.	ColorScript 210	Thermal	$4995	—	0.70	—	—	0.38	0.54
QMS, Inc.	ColorScript 230	Thermal	$7995	—	0.73	—	—	0.34	0.58
Seiko Instruments	Colorpoint PSN	Thermal	$5999	—	0.76	—	—	0.42	0.70
Star Micronics America, Inc.	SJ 144	Thermal	$599	0.62	—	0.38	0.38	—	—
Star Micronics America, Inc.	XB-2425	Dot-matrix	$799	1.10	—	0.22	0.51	—	—
Tektronix, Inc.	Phaser 200e	Thermal	$3695	—	1.19	—	—	0.57	0.92
Tektronix, Inc.	Phaser 200i	Thermal	$5995	—	1.49	—	—	0.75	0.99
Tektronix, Inc.	Phaser III PXi	Solid ink	$9995	1.07	0.47	—	—	0.25	0.45
Tektronix, Inc.	Phaser IISDX	Dye-sub.	$9995	—	0.30	—	—	0.27	0.32

[1] With $349 PowerStep accelerator option. [2] Couldn't complete test suite. (BYTE logo) = BYTE Best. ● = Yes ○ = No

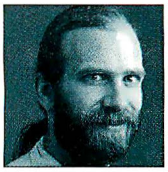
	Emulations									
HP DESKJET 500/500C/550C	POSTSCRIPT	PCL5 (HP LJIII)	PCL4 (HP LJ 4)	HPGL	EPSON LQ/FX	IBM PROPRINTER	IBM GRAPHICS	TOLL-FREE	PHONE	INQUIRY NO.
○	Level I	Opt.	●	●	○	○	○	(800) 888-1689	(714) 641-8600	1412
○	Level I	Opt.	●	●	○	○	○	(800) 888-1689	(714) 641-8600	1413
○	Level I	Opt.	●	●	○	○	○	(800) 888-1689	(714) 641-8600	1414
○	○	●	○	●	○	●	○	(800) 654-3282	(609) 235-2600	1415
○	○	○	●	○	○	○	○	(800) 654-3282	(609) 235-2600	1416
○	Level I	○	●	○	○	○	○	(800) 654-3282	(609) 235-2600	1417
○	Level I	○	●	○	○	○	○	(800) 654-3282	(609) 235-2600	1418
○	○	●	○	●	○	○	○	(800) 742-8086	(201) 348-7000	1419
○	Level I	○	●	○	○	○	○	(800) 742-8086	(201) 348-7000	1420
—	—	—	—	—	—	—	—	(800) 631-2692	(205) 633-4500	1255
○	Level I	○	●	Opt.	○	○	○	(800) 631-2692	(205) 633-4500	1090
○	Level I	○	●	○	○	○	○	(800) 631-2692	(205) 633-4500	1091
○	Level I, II	○	●	●	○	○	○	(800) 631-2692	(205) 633-4500	1092
○	Level I	●	●	●	●	●	●	(800) 446-0262	(201) 229-4000	1093
○	○	○	●	○	○	●	●	(800) 732-8221	N/A	1094
○	Level I	○	●	●	○	○	○	(800) 449-4700	(908) 572-3300	1095
○	Level I	○	○	●	○	●	○	N/A	(817) 390-3011	1096
○	Level II	●	○	○	○	○	○	(800) 527-3500	(817) 774-6001	1097
○	Level II	●	○	○	○	○	○	(800) 527-3500	(817) 774-6001	
○	Level I	○	●	○	Opt.	Opt.	○	(800) 527-3500	(817) 774-6001	1098
○	Level I	○	●	○	Opt.	Opt.	○	(800) 527-3500	(817) 774-6001	1099
○	Level I	○	●	○	Opt.	Opt.	○	(800) 527-3500	(817) 774-6001	1100
○	Level I, II	○	●	○	Opt.	Opt.	○	(800) 527-3500	(817) 774-6001	1101
○	Level I	○	●	○	Opt.	Opt.	○	(800) 527-3500	(817) 774-6001	1102
○	Level I, II	○	●	○	Opt.	Opt.	○	(800) 527-3500	(817) 774-6001	1103
○	Level I Opt.	●	○	●	●	●	○	(800) 334-3445	(714) 583-3000	1104
○	Level I Opt.	●	○	●	○	●	○	(800) 334-3445	(714) 583-3000	976
○	Level I	○	●	○	○	○	○	(800) 926-8839	(205) 476-8189	977
○	●	○	●	○	○	○	○	(800) 926-8839	(205) 476-8189	978
○	Level I, II	○	●	○	○	○	○	(800) 926-8339	(205) 476-8189	979
○	Level I	○	●	○	○	○	○	(800) 832-6979	(310) 333-2202	980

	Emulations									
HP DESKJET 500/500C/550C	POSTSCRIPT	PCL5 (HP LJIII)	PCL4 (HP LJ 4)	HPGL	EPSON LQ/FX	IBM PROPRINTER	IBM GRAPHICS	TOLL-FREE	PHONE	INQUIRY NO.
○	—	○	○	—	○	○	○	(800) 776-2333	(408) 996-1010	981
○	—	○	○	—	○	○	○	(800) 866-9797	(801) 466-9797	982
○	—	○	○	—	●	●	●	(800) 276-7746	(908) 356-8880	983
○	—	○	○	—	●	●	○	(800) 848-4123	(714) 438-3000	984
○	—	○	○	—	○	●	○	(800) 447-4683	(310) 453-0614	985
●	—	○	○	—	○	●	○	(800) 344-0006	(716) 253-0740	986
●	—	○	○	—	○	○	○	(800) 752-0900	(208) 323-2551	987
●	—	○	○	—	●	●	○	(800) 426-2468	(606) 232-3000	988
○	—	○	○	—	●	●	○	(800) 426-2468	(606) 232-3000	989
○	—	○	●	—	●	●	○	(800) 843-1347	(206) 251-5500	990
○	—	○	●	—	○	○	○	(800) 843-1347	(206) 251-5500	991
○	—	○	○	—	○	●	●	(800) 338-2609	(201) 327-7227	992
○	—	○	○	—	●	●	○	(800) 447-4700	(908) 572-3300	993
○	—	○	○	—	○	●	○	N/A	(817) 390-3011	994

Class			Emulations								
QUALITY	PPM	CPS	DPI	POSTSCRIPT	HPGL	EPSON LQ/FX	IBM PROPRINTER	IBM GRAPHICS	TOLL-FREE	PHONE	INQUIRY NO.
3.59	—	480	480	○	○	●	●	○	(800) 992-2264	(805) 388-5799	995
4.20	—	800	240	○	○	●	●	○	(800) 825-2577	(408) 432-6000	996
6.93	3.50	2.5 ppm	360	○	○	○	○	○	(800) 776-2333	(408) 996-1010	997
3.96	—	337	360	○	○	●	●	○	(800) 276-7746	(908) 356-8880	998
8.27	1.00	—	300	Level I, II	○	○	○	○	(800) 225-2667	(714) 821-2000	999
7.33	—	300	360	○	○	●	●	○	(800) 848-4123	(714) 438-3000	1221
3.86	—	270	240	○	○	○	●	●	(800) 477-4683	(310) 453-0614	1222
3.68	—	270	360	○	○	●	●	○	(800) 477-4683	(310) 453-0614	1223
4.43	—	300	360	○	○	●	●	○	(800) 477-4683	(310) 453-0614	1224
4.59	—	250	72	○	○	●	○	○	(800) 334-3174	(818) 887-8000	1225
8.19	2.00	—	300	Level II	○	●	○	○	(800) 334-3174	(818) 887-8000	1226
5.06	—	300	360	○	○	●	●	○	(800) 344-4825	(508) 493-5111	1227
8.34	3.50	—	300	Level II (Level I opt.)	○	○	○	○	(800) 344-0006	(716) 253-0740	1228
4.31	—	200	360	○	○	●	●	○	(800) 826-6112	(408) 432-6333	1229
7.71	2.00	—	300	Level I, II	●	○	○	○	(800) 223-0999	(510) 524-1060	1230
7.00	1.30	—	300	Level I, II	●	○	○	○	(800) 223-0999	(510) 524-1060	1231
7.29	1.00	—	300	○	●	○	○	○	(800) 752-0900	(208) 323-2551	1232
7.29	1.00	—	300	Level I, II	●	●	●	●	(800) 752-0900	(208) 323-2551	1233
4.86	—	240	300	○	○	○	○	○	(800) 752-0900	(208) 323-2551	1234
7.35	2.00	—	300	Level II opt.	●	○	○	○	(800) 752-0900	(208) 323-2551	1235
7.87	—	167	360	○	○	○	○	○	(800) 426-2468	(606) 232-3000	1236
2.61	—	300	240	○	○	●	●	●	(800) 843-1347	(206) 251-5500	1237
3.56	—	360	360	○	○	●	●	○	(800) 654-3282	(609) 235-2600	1238
3.21	—	240	360	○	○	●	●	○	(800) 742-8086	(201) 348-7000	1239
4.21	—	300	360	○	○	●	●	○	(800) 742-8086	(201) 348-7000	1240
2.89	—	240	216	○	○	○	●	●	(800) 742-8086	(201) 348-7000	1241
7.84	1.00	—	300	Level I, II	●	○	○	○	(800) 631-2692	(205) 633-4500	1242
7.69	1.00	—	300	Level I, II	●	○	○	○	(800) 631-2692	(205) 633-4500	1243
7.56	1.00	—	300	Level II	○	○	○	○	(800) 825-9711	(408) 922-5900	1244
5.75	—	382	360	○	○	○	●	○	(800) 447-4700	(908) 572-3300	1245
4.03	—	375	360	○	○	●	●	●	(800) 447-4700	(908) 572-3300	1246
7.25	2.00	—	300	Level II	●	○	○	○	(800) 835-6100	(503) 682-7377	1247
6.36	2.00	—	300.00	Level II	●	○	○	○	(800) 835-6100	(503) 682-7377	1248
8.29	1.00	—	300.00	Level II	●	○	○	○	(800) 835-6100	(503) 682-7377	1249
9.29	1.00	—	300.00	Level II	●	○	○	○	(800) 835-6100	(503) 682-7377	1250

Digital Signatures

Cryptographic algorithms can create nonforgeable signatures for electronic documents, making them valid legal instruments



BRUCE SCHNEIER

For ages, special seals or handwritten signatures on documents have served as proof of authorship of, or agreement with, the contents of a document. Several attributes make the use of handwritten signatures compelling. These include the following:

- A signature is not forgeable and serves as proof that the signer deliberately signed the document.
- A signature is authentic and convinces the recipient that the signer deliberately signed the document.
- A signature is not reusable. It's part of the document, and an unscrupulous person cannot transfer it to a different document.
- Once signed, a document is unalterable.
- A signature cannot be repudiated. Since the signature and the document are physical objects, the signer cannot later claim that he or she didn't sign it.

These attributes would all hold true in an ideal world; in reality, however, none of them is completely true. Signatures can be forged, or they can be lifted off one piece of paper and moved to another. Documents can be altered after they are signed. But for simplicity's sake, I'll assume that the signatures discussed in this article exist in an ideal world.

It would be nice to have nonforgeable signatures on computer documents, but there are problems with this concept. First, bit streams are easy to copy; the mere presence of such a signature means nothing. Even if a person's signature was made difficult to forge—if it was accompanied by a graphical image of a fingerprint, for example—with today's cut-and-paste software it's all too easy to move a valid signature from one document to another. Second, documents are easy to modify after they are signed, without leaving any evidence of modification.

So, when you receive a piece of E-mail containing critical information, how do you know who it is from? Can you be sure that the "from" line isn't forged? Are you certain that someone hasn't tampered with the document's contents during transit? If necessary, could you prove any of this in court?

Digital signatures are an attempt to create documents that can be mathematically and legally traced to their authors. A *digital signature* is a string of bits attached to an electronic document, which could be a word processing file or an E-mail message. This bit string is generated by the signer, and it's based on both the document's data and the person's secret password. Someone who receives the document can prove—both to himself or herself and to a court—that the signer actually signed the document. If the document is altered, the signer can also prove—to himself and to a court—that he did not sign the altered document.

Digital Signatures Defined

Public-key cryptography can be used for digital signatures. Public-key cryptography uses special encryption algorithms with two different keys: a public key that every-

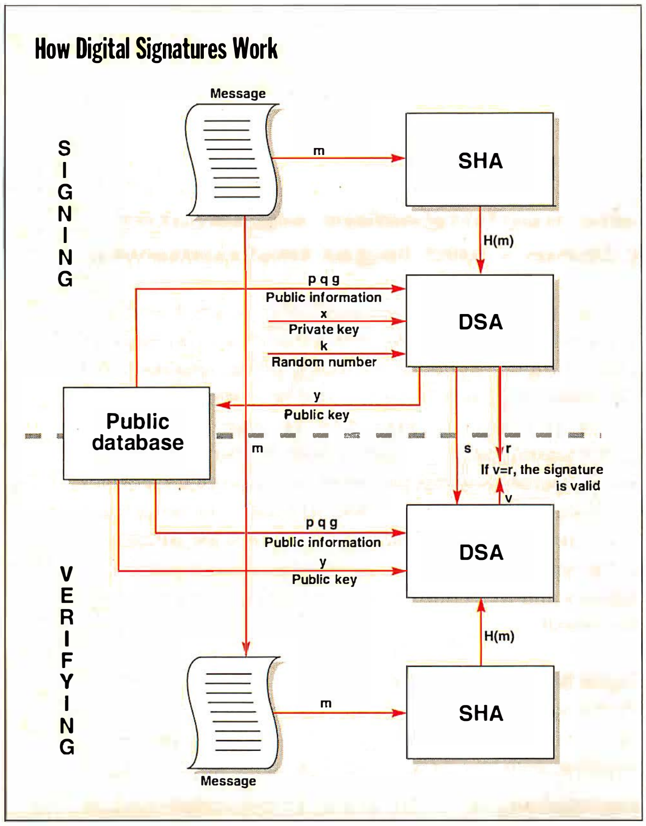


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one knows, and a private key that only one person knows. The term *key,* as it's used here, describes a unique bit pattern. Public-key algorithms encrypt the contents of an electronic document using both keys. The resulting file is a amalgam of both the public and private keys and the original document's contents.

This technique accomplishes several things. First, the file's data is secure because of the private key. Because

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Suppose an electronic document *or message* (m) *is to serve as a legal instrument. The signer uses the SHA to create a hash value of the document's contents,* H(m). *Next, the signer selects public prime numbers* p, q, *and* g, *a random number* k, *and a private key* x. *These values and the hash are supplied to the DSA, which creates the signature values* s *and* r. *The verifier provides the DSA with the document's hash value; the signature* s; *the same* p, q, *and* g; *and the public key* y. *If the result* (v) *from the verifier's DSA matches the other signature value* r, *then the signature is valid. This also proves that the document's contents have not been altered.*

the file's data also relies on the public key, anyone owning the public key can verify the file's authenticity. Since this file is also a function of the original document's contents, any alteration to the encrypted file causes the verification to fail. Finally, it is computationally infeasible (on the order of thousands of years) to calculate the private key from the public key.

For example, suppose Alice signs a document for Bob using her private key. Ignoring the mathematics for a moment, the digital signature works like this: Alice (the signer) generates a mathematical function of her private key and the document. This is the signature. Bob (the verifier) then generates a mathematical function of Alice's public key and her signature. If this function matches the document, the signature is valid. If it does not, the signature is not valid. The point here is that the security of the digital signature algorithm prevents someone from pretending to be Alice and forging her signature.

This arrangement satisfies the signature characteristics we're looking for:

- The document's signature is not forgeable, since only Alice knows her private key.
- The signature is authentic. When Bob verifies the message with Alice's public key, he knows that she signed it.
- The signature is not reusable; the signature is a function of the document and cannot be transferred to any other document.
- The signed document is unalterable; any alteration makes the document unverifiable with Alice's public key.
- The signature cannot be repudiated. Bob doesn't need Alice's help to verify her signature.

Notice that these features nicely match the list of attributes discussed earlier with regard to handwritten signatures. Best of all, Alice and Bob don't have to meet face-to-face or exchange any physical pieces of paper. With possession of Alice's public key, Bob can be certain that the purchase order for 10,000 widgets that he receives from her through an E-mail service is valid.

The Digital Signature Standard

In 1991, NIST, the National Institute of Standards and Technology, proposed the DSA (Digital Signature Algorithm) for the then-new DSS (Digital Signature Standard). The mathematical algorithm was developed at NSA, the National Security Agency, and is related to other digital signature algorithms in the academic literature (see the bibliography).

The DSA uses the following parameters:

- p, which equals a prime number 2^L bits long, where L ranges from 512 to 1024 and is a multiple of 64. (In the original standard, the size of p was fixed at 512 bits. This was changed after much criticism.)
- q, which equals a 160-bit prime factor of p–1.
- g, which equals $h(p-1)/q$, where h is any number less than p–1 such that $h(p-1)/q \bmod p$ is greater than 1.
- x, which is a number less than q.
- y, which equals $gx \bmod p$.

Additionally, the algorithm makes use of a one-way hash function: the SHA (Secure Hash Algorithm). Details will come later; for now, it's just $H(x)$.

The first three parameters, p, q, and g, are public and can be common across a network of users. The individual private key is x; the individual public key is y.

Now back to the example. Alice wants to sign a message, m. First she generates a random number k that is less than q. Then she generates $r = (g^k \bmod p) \bmod q$, and $s = (k\text{–}1\ (H(m) + xr)) \bmod q$. The parameters r and s are her signature. They can be sent with her message or stored separately (see the figure "How Digital Signatures Work").

Bob wants to verify a signature, r and s, of message m. He knows p, q, and g, plus Alice's individual public key, y. Bob computes the following:

$$w = s^{-1} \bmod q$$
$$u1 = (H(m) * w) \bmod q$$
$$u2 = (r * w) \bmod q$$
$$v = ((g^{u1} * y^{u2}) \bmod p) \bmod q$$

If $v = r$, then the signature is verified as Alice's.

Proofs for the mathematical relationships are found in the NIST documentation. Essentially, Alice is generating two parameters, r and s, that are functions of her message, her private key, and a random variable. For an adversary to be able to forge Alice's

signature, he or she has to be able to recover x from r and s. This problem is conjectured (although not proved) to be equivalent to solving the discreet logarithm problem mod p. As I will show later, this is computationally impossible.

Real-world implementations of the DSA can be speeded up through precomputations. Note that the value r is not dependent on the message. You can create a string of random k values and then precompute r values for each of them. You can also precompute k–1 for each of those k values. Then, when a message comes along, you can compute s for a given r and k–1. This precomputation speeds up the DSA considerably.

Public and Private Keys

Certain values of p and q are much easier to crack than others. If someone used one of these "cooked" moduli (i.e., values), then his or her signature would be easy to forge. This isn't a problem, for two reasons: The moduli for which this property holds true are easy to detect, and these moduli are so rare that the chances of using one when choosing a modulus randomly are negligibly small—smaller, in fact, than the chances of accidentally generating a composite number using a probabilistic prime-generation routine.

NIST recommends the use of the secure method shown in the text box "Steps for Generating Two Primes for a Digital Signature." This method ensures that there is a public means of generating p and q. For all practical purposes, the two-primes method prevents the use of "cooked" values for p and q. If someone were to hand you a p and a q, you might wonder where the person got them. However, if somebody hands you the values for S and C that generate the random p and q, you can work through this routine to derive p and q. Since this is a one-way function, it prevents someone from working backward to create a bogus S and C.

Implementation and Security

The mathematics of the DSS are straightforward. The hardest part is the software that's required to perform arithmetic operations on numbers that are 1000 bits long.

As for security, NIST's announcement of the DSA/DSS standard created a maelstrom of criticisms and accusations that were more of a political than an academic nature. RSA Data Security, the purveyor of the RSA algorithm, led the charge against DSS. The company wanted RSA, and not another algorithm, to be used as the standard (see the text box "RSA Digital Signatures").

But the only technical criticism of DSS's security was the key size. The original standard required only 512-bit keys. Since the algorithm gets its security from the difficulty of computing discrete logs modulo p, this was worrisome to most cryptographers. There have been advances in the problem of calculating discrete logarithms in a finite field, and 512 bits is too short for long-term security. It's possible to crack 512-bit keys in a matter of months or years, which is far too short an interval for special contracts and diplomatic agreements that must survive 40 years or longer.

In response, NIST made the key size variable, from 512 bits to 1024 bits. It would take all the world's computers far longer than the age of the universe to calculate a discrete logarithm modulo a 1024-bit number.

The Secure Hash Algorithm

In practical implementations, the DSA is too inefficient to sign long documents directly. In the standard, the DSA is implemented with the SHA. Therefore, in my example, instead of signing a document, Alice signs the hash of the document (i.e., a value that is generated by a hash algorithm operating on the document's data).

The NIST and NSA designed the SHA for use with the DSA. The standard itself is called the SHS (Secure Hash Standard); SHA is the algorithm used in the standard.

The SHA speeds encryption times drastically, and since the chances of two different documents' having the same 160-bit hash are only one in 2^{160}, anyone can safely trust a signature of the hash to represent a signature of the document.

If a two-way hash function were used, it would be a trivial matter to create multiple documents that hashed to the same value, so anyone who signed a particular document could, in a sense, be duped into signing a multitude of documents. Therefore, this protocol cannot work without one-way hash functions.

The SHA accepts an arbitrary-length message input and produces a 160-bit message-digest output. The algorithm is complicated, but it's straightforward. First, the message is padded so that it is a multiple of 512 bits long. Next, the algorithm appends a 1, and then as many zeros as necessary to make the message's length 64 bits short of a multiple of 512. Finally, a 64-bit value that represents the message's length before padding is tacked onto the message.

Five 32-bit variables, as defined by the SHS, are initialized with the following hexadecimal values:

Steps for Generating Two Primes for a Digital Signature

This algorithm generates the two primes p and q, such that p divides p–1. The prime p is between 512 and 1024 bits long, for some multiple of 64 bits. The prime q is 160 bits long. Let $L-1 = n^{160+b}$, where L is the length of p, and n and b are two numbers.

1. Choose an arbitrary sequence of at least 160 bits and call it S. Let g be the length of S in bits.
2. Compute U = SHA(S) xor SHA((S+1) mod 2g).
3. Form q from U by setting both the most significant bit and the least significant bit to 1.
4. Check to see whether q is prime.
5. If q is not prime, go back to step 1.
6. Let C = 0 and N = 2.
7. For k = 0,1,...,n, let Vk = SHA((S + N + k) mod 2g).
8. Let W = $V0$ + $V1$*2160 + ... + Vn–1*2(n–1)*160 + (Vn mod 2b)*2n*160 and X = W + 2L–1. Note that X is a 2L-bit number.
9. Let p = X–((X mod 2q)–1). Note that p is congruent to 1 mod 2q.
10. If p< 2L–1, go to step 13.
11. Check to see whether p is prime.
12. If p is prime, you're done; go to step 15.
13. Let C= C+1 and N = N+n+1.
14. If C = 4096, go to step 1. Otherwise, go to step 7.
15. Save the value of S and the value of C used to generate p and q.

RSA Digital Signatures

Another public-key cryptography algorithm, RSA, can be used to implement digital signatures. A patent was awarded to MIT in 1983 for the RSA algorithm; a year later, RSA Data Security, Inc. (Redwood City, CA), was founded to market and license it.

The algorithm's name comes from the first letters of the last names of its creators: Ron Rivest, Adi Shamir, and Leonard Adelman. RSA digital signatures are an ISO standard (ISO/IEC 9796) and a French banking standard (Etebac 5). NIST (the National Institute of Standards and Technology) didn't use RSA for its own standard because of patent problems: RSA is patented in this country, but not abroad.

With RSA, the public key consists of two numbers, n and d. The variable n is the product of two secret primes, p and q. The variable d is a random number, relatively prime to $(p-1)*(q-1)$. The private key is e, calculated such that $d*e = 1 \bmod (p-1)*(q-1)$.

To sign a message m, you first use a one-way hash function to compute the hash of m: $H(m)$. The signature, s, is $H(m)^e \bmod n$. To verify the signature, you calculate $s^d \bmod n$. If $s = H(m)$, then the signature is valid.

AA = 67 45 23 00
BB = EF CD AB 89
CC = 98 BA DC FE
DD = 10 32 54 76
EE = C3 D2 El F0

The main loop of the algorithm then begins. It processes the message 512 bits at a time and continues for as many 512-bit blocks as are in the message.

First the five variables are copied into different variables: AA into A, BB into B, CC into C, DD into D, and EE into E. The main loop has four rounds of 20 operations each. Each operation performs some nonlinear operation on A, B, C, and D and then does shifting and adding.

The SHA's set of nonlinear functions are as follows:

f_t(X,Y,Z) = XY or (not X) Z, for the first 20 operations.

f_t(X,Y,Z) = X xor Y xor Z, for the second 20 operations.

f_t(X,Y,Z) = XY or XZ or YZ, for the third 20 operations.

f_t(X,Y,Z) = X xor Y xor Z, for the fourth 20 operations.

There are also four hexadecimal constants used in the algorithm. They are as follows:

K_t = 5A827999, for the first 20 operations.

K_t = 6ED9EBA, for the second 20 operations.

K_t = 8F1BBCDC, for the third 20 operations.

K_t = CA62C1D1, for the fourth 20 operations.

The message block is transformed from 16 32-bit words (M_0 to M_{15}) to 80 32-bit words (W_0 to W_{79}) by using the following algorithm:

$W_t = M_t$, for t = 0 to 15;
$W_t = W_t$ –3 xor W_t –8 xor W_t –14 xor W_t –16, for t = 16 to 79

If t is the operation number (from 1 to 80), and M_j represents the jth sub-block of the message (from 0 to 15), and <<<s represents a left shift of s bits, then the 80 operations look like the following:

TEMP = (A <<< 5) + f_t(B,C,D) + E + W_t + K_t
E = D
D = C
C = (B <<< 30)
B = A
A = TEMP

After all this, A, B, C, D, and E are added to AA, BB, CC, DD, and EE, respectively, and the algorithm continues with the next block of data. The final output is the concatenation of A, B, C, D, and E.

Using the SHA has two other benefits besides reducing the length of the message to be signed. The signature is kept separate from the document, and the recipient's storage requirements for the document and signature are much smaller.

An archival system can use this type of protocol to verify the existence of documents without storing their contents. The central database could just store the hashes of files. It doesn't have to see the files at all; users submit their hashes to the database, and the database time-stamps the submissions and stores them. If there is ever any disagreement about who created a document and when, the database could resolve it by finding the hash in its files. This has vast implications concerning privacy: Alice could copyright a document but still keep the document secret. Only if she wished to prove her copyright would she have to make the document public. ■

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Bruce Schneier has an M.S. in computer science and has worked in computer security and cryptography. He is the author of Applied Cryptography *(John Wiley & Sons, 1993). You can contact him on BIX c/o "editors" or on the Internet at schneier@chinet.com.*

OS/2 Extended Attributes

What they are, why they break, and how to fix them



MARK J. MINASI

I recently reinstalled OS/2 2.1 on a system. On the first boot, I got a number of messages, which I'm unfortunately now quite familiar with, about "lost" and "cross-linked" EAs (extended attributes). I got tired of seeing these messages, so I looked into what causes them and found some interesting things.

With OS/2 1.2's introduction on Thanksgiving weekend of 1989 came a new file system named the High Performance File System, or HPFS. Among the HPFS's features was the ability to extend a file's attributes beyond the traditional four—read-only, hidden, system, and archive—allowing programmers to create attributes that were appropriate to a particular application.

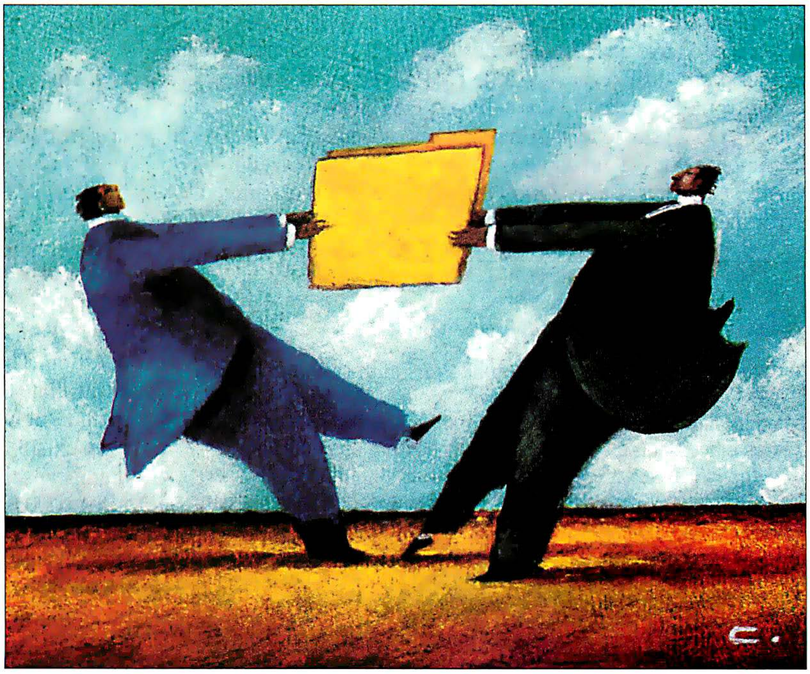
Microsoft and IBM believed that EAs would become a big deal, but nobody really used them except in the operating system itself. Microsoft liked EAs so much, however, that it came up with a way to shoehorn them back into the FAT-based (file allocation table) file system. EAs were a minor irritant in OS/2 1.2 and 1.3, but they're very important under OS/2 2.x: Much of OS/2's Workplace Shell information (e.g., icons, colors, and window placement) is encoded into EAs. So EA problems under OS/2 2.x often mean system crashes.

First, you need to look at how EAs are represented in the FAT-based file system. As you may know, the FAT-based file system uses the directory and the FAT as a pair: The directory tells your system what files you have, and the FAT tells the system where those files are. DOS first looks to the directory to find out file size, name, date, and where to go in the FAT to get more information. Then the system follows the FAT pointer to the indicated area of the FAT, which, in turn, describes exactly where on disk to find the files.

Microsoft decided to store the EAs on the disk in the data area, alongside the files. Each file's EAs occupy at least one cluster of hard disk space. (Clusters are fixed-size areas on disk; the size is most commonly 2 KB, but it can be as large as 16 KB.) Now, a cluster can't just sit out on disk without OS/2's knowledge (otherwise, OS/2 would just overwrite the area), so each cluster in the FAT must be marked as *taken.*

But taken by what? A cluster that claims it is occupied but has no owner in the directory is called a *lost cluster* and considered an error condition. In fact, if many utilities—one of them being CHKDSK—find such a cluster, it is removed. So each EA cluster must have an owner. Microsoft solved that problem by making all the separate EA clusters one big file called EA DATA. SF. The space between EA and DATA. and between DATA. and SF makes it difficult to mess around with or erase the file.

Now you need to know how the system knows which files go with what EAs. Each DOS directory entry has 10 bytes of unused space. It's a relic that DOS 1.0 inherited from CP/M, which used that space to hold file allocation information. As the file allocation information appeared elsewhere in DOS, that left 10 unused bytes. What Microsoft did was to use the first two of those unused bytes for something that I'll call an *extended attribute pointer*, or EAP. The figure "Relationship Among DOS Directory, FAT, and Extended Attributes" shows how the directory entries, FAT entries, EAPs, and EAs might look for two files. Now that you've seen the FAT and EA pointers depicted, it may be obvious what can go wrong with EAs under a FAT-based system. Just as the directory-to-FAT links can become damaged, leading to the unfortunately familiar lost clusters and cross-linked clusters, so, too, can the directory-to-EA links cause problems. These problems manifest themselves in a number of ways.



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continued

Cross-Linked EAs

Of the three EA-related problems, cross-links are the worst. Sometimes a CHKDSK run will show an error message explaining that a file is cross-linked on an EA. This just means that one file's EAP and another file's EAP point to the same place (e.g., both lay claim to cluster 150 of EA DATA. SF). CHKDSK can't fix this problem; it can only complain about it, because two files both claim ownership of an EA. How can CHKDSK know which one is telling the truth? The only options that the designers of CHKDSK would have would be to first disconnect one file's EAP, trashing an EA for a file that might need it; second, disconnect both file's EAP; or third, copy an EA to another part of EA DATA. SF and point the second file's EAP to the copy.

Consider this scenario. You install OS/2 and use it for a while, but you run into some kind of trouble—the desktop disappears and you don't have a backup, or the like. So you decide to reinstall OS/2. Before you do, however, you completely remove the previous copy of OS/2, eliminating every single OS/2-related file, including EA DATA. SF. This is generally a good procedure; for example, many OS/2 betas have recommended installing OS/2 fresh on your disk, not on top of a previous copy of OS/2. Furthermore, experience shows that OS/2 installed atop a damaged copy of OS/2 sometimes does not overwrite the troubled parts of the older OS/2 installation.

Now suppose you reinstall OS/2; you now have a brand-new EA DATA. SF file that contains information only on the newly installed OS/2 files. Perhaps, for example, the file CMD.EXE has a pointer that refers it to EA cluster 200. But consider the files that you didn't erase that contain the EA pointers. What if one of those files used to have an EA in EA cluster 200? It still contains a pointer that points to EA cluster 200. That's where cross-linked EAs come from. So, to avoid cross-linked EAs, remember: When removing OS/2 prior to reinstalling OS/2, do not erase EA DATA. SF.

Suppose you've already got cross-linked EAs. What do you do then? Take a look at the following example of a cross-linked EA error message from CHKDSK:

```
  SYS1324: C:\UTIL\X.EXE is cross-linked on
extended attribute 110.

  SYS1324: C:\UTIL\Y.EXE is cross-linked on
extended attribute 111.

  SYS1324: C:\OS2\DLL\IMP.DLL is cross-linked
on extended attribute 110.

  SYS1324: C:\OS2\DLL\NLS.DLL is cross-linked
on extended attribute 111.
```

Listed are two pairs of files—X.EXE/IMP.DLL and Y.EXE/NLS.DLL. In each case, only one of these files is the rightful owner of the EA. Which is it? Well, if you've just reinstalled OS/2, then it's easy—the OS/2 files. Otherwise, you may have to experiment a little. You do this with EAUTIL. The OS/2 documentation has more information on EAUTIL, but briefly, you can use EAUTIL/S to split EAs from their files and EAUTIL/J to join an EA with a file.

To fix NLS.DLL and Y.EXE, I would first use EAUTIL/S to remove the EA from NLS.DLL. That would, in passing, erase the EAP in NLS.DLL; the EAP in Y.EXE would still be in place. To get rid of the EAP in Y.EXE, the best answer is probably to cheat and boot under DOS. DOS has no knowledge of EAPs, so most DOS operations blithely overwrite any EAPs. Just copy Y.EXE to YY.EXE and then rename it back to Y.EXE, and the EAP will be gone. Then reboot under OS/2 and reattach the EA to NLS.DLL with EAUTIL/J.

Lost EAs

By now, you have seen that a *lost* EA is an EA cluster that has no EA pointer pointing to it. When CHKDSK/F comes across such a cluster, it prints a message that says "Lost extended attributes have been found. Do you want to display them as files (Y/N)?"

If you tell CHKDSK to make them files, it gives them names such as EA0000.CHK. You can rejoin them to files using the EAUTIL program. On the other hand, if you know that you'll never use them, you can free up the space by answering "no" to the question. The error message "Has attempted to claim an extended attribute that does not exist..." occurs when a pretender points to an EA cluster that it doesn't own; in fact, the cluster doesn't even exist. Suppose your EAs used to range up to 2000 clusters; that means that some file out there has an EA pointer with a value of 2000. But then suppose you blast OS/2 and the EA DATA. SF file, reinstalling OS/2 and incidentally re-creating EA DATA. SF. But the new installation only has about 400 EA clusters. That means that the old pretender, which still thinks it has an EA—but doesn't—points to an EA whose value is above the highest EA value known to OS/2. Result: the above message. CHKDSK/F fixes the problem by blanking out the pointer.

EA problems are an unfortunate side effect of the nature of the Workplace Shell. Knowing how to handle their vagaries will make you better-equipped to solve the certain problems that will pop up now and then due to EAs. ■

Mark J. Minasi is the author of Troubleshooting Windows, The Windows Problem Solver, *and* Inside OS/2 2.1. *His firm gives seminars on OS/2 and Windows in the U.S., Canada, and Europe. You can reach him on BIX as "mjminasi" or on CompuServe as 71571,264.*

Correction and Amplification

We'd like to correct some factual errors in the October Beyond DOS column "The Visual Toolbox." Mark J. Minasi mistakenly confused VREXX, a product originally developed by IBM (which has since been placed in the public domain as shareware), with VisPro/REXX, a commercial product developed by Hock-Ware (Cary, NC). In the column, Minasi gives a short programming example of how to create a dialog box for an OS/2 program using VisPro/REXX, but the code is for VREXX. The column also attributed erroneously two drawing functions—VDraw and VArc—to VisPro/REXX when they are, in fact, part of VREXX.

In addition, the column incorrectly stated that "VisPro/REXX is simply a bunch of new [OS/2] REXX functions." In fact, VisPro/REXX offers developers a visual-programming environment that's CUA 1991–compliant. Minasi reported that he experienced dropped numbers when using VisPro/REXX's sample calculator application; but at BYTE, using a different PC and mouse, we were unable to duplicate that experience. Although not in error at the time of publication, Watcom International's VX-REXX price jumped from $99 to $199 on October 1.

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NT's Structured Exception Handling

Windows NT's structured exception handling gives you clutter-free, reliable, and tighter code. But the price may not be worth the effort.

STEVE NIEZGODA, LLOYD HOLT, AND DEREK WOJCIECH

Microsoft wants to convince software developers that Windows NT is the operating system for the next generation of software. One tack it's taking to prove its case is touting NT's structured-exception-handling architecture, claiming it ensures robustness at all levels of the operating system. It's a good argument. Structured exception handling has many benefits. It lets you avoid cluttering code with conditional statements that check each operation's inputs and results, thereby diverting attention from the algorithm. It reduces the overall amount of code because calling routines don't need to perform the same tests as invoked routines. Finally, it gives you a mechanism for handling errors that can't be checked with preconditions.

But the promise of more reliable software raises some questions: Should you use structured exception handling in new software development? Can you retrofit it to your legacy applications? What are the benefits of NT structured exception handling in performance, program size, and source code readability? We set out to answer those questions by testing the toughness of NT's structured exception handling.

NT structured exception handling provides many benefits, such as recovery from memory errors and hardware traps. But it is not the software developer's cure-all. You pay for its benefits in reduced performance. And for legacy applications, the price of retrofitting may be too high.

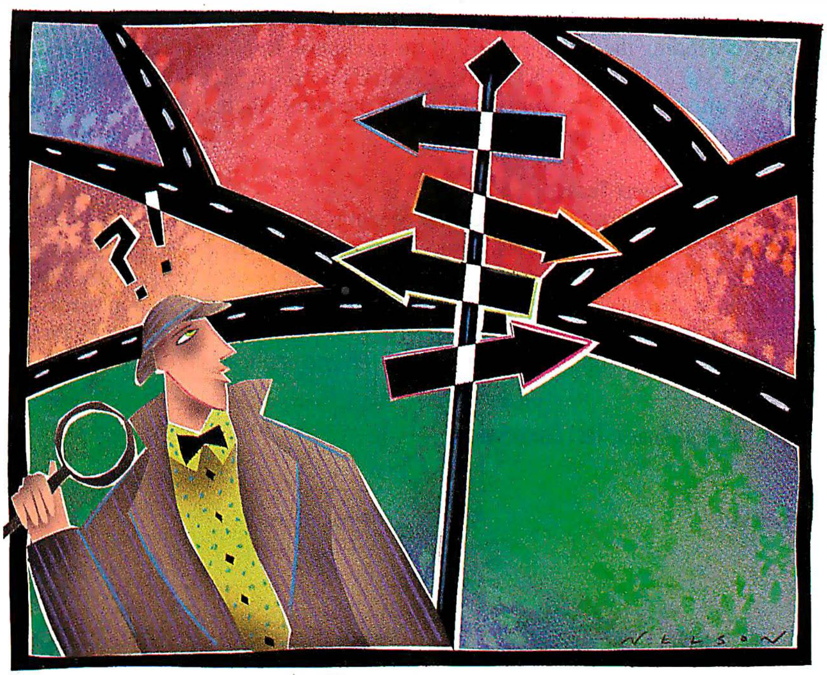
Categories of Exceptions

You can classify NT exceptions into two categories: kernel- and user-defined. Kernel-defined exceptions include hardware traps, math or memory errors, and debugger instructions. User-defined exceptions are generated through the Win32 API routine `RaiseException()`, which transfers control to a user-written, frame-based exception handler.

Often, both the operating system and the programming language cooperate to handle an exception. (Some exceptions, like debugger instructions, are handled exclusively by the operating system.) The operating-system component is the exception dispatcher. The language component is the frame-based exception handler.

All NT exceptions are serviced by a kernel module called the *exception dispatcher*. When an exception occurs while your CPU is in kernel mode, the exception dispatcher invokes the appropriate frame-based exception handler. If it can't find one, a fatal error exists and `ExitWindows()` is called. When exceptions turn up while your CPU is in user mode, the dispatcher locates an exception handler by performing the search shown in the figure "Systematic Search for an Exception Handler." If it can't locate a handler, it invokes the kernel default handler, `ExitProcess()`.

Your compiler handles the frame-based exception-handling mechanism. Using language constructs, a code block can be guarded by several exception handlers. When invoked, the code block's local variables and parameters (the stack frame) are pushed onto the program stack. The exception handlers guarding the code block are statically associated with this stack frame during compilation. When an exception occurs, the exception dispatcher dynamically searches for the exception handlers associated with the current stack frame. If none is found, the dispatcher continues searching the call stack. This process is known as *unwinding the stack*.



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Structured Exception Mechanics

To support structured exception handling, Microsoft extended the C language by adding the keywords `try` and

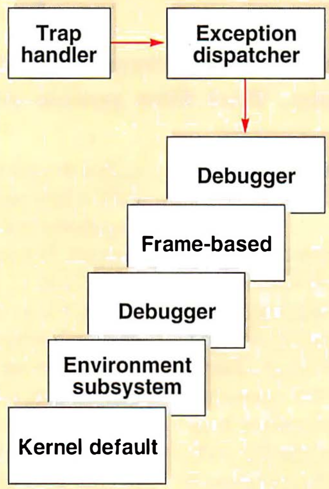
`except`. These keywords mark, respectively, the beginnings of the guarded code block and the exception logic. This is the syntax:

```
try-except-statement ::=
  try compound-statement
      except (expression)
      compound-statement
```

The first compound-statement is the guarded statement or body. `Expression` represents the exception filter. The second compound-statement is the exception handler. Microsoft also added several compiler-independent, exception-handling system service calls to the Win32 API, including `RaiseException()`.

If an exception happens within the body of a `try-except` statement, an exception filter is evaluated to determine the program's course of action. If the filter evaluates to EXCEPTION_EXECUTE_HANDLER, control is transferred to the exception handler. This transfer is similar to a C `longjmp()`; stack frames are wound back to (but not including) the frame of the `try` statement. If the filter evaluates to EXCEPTION_CONTINUE_SEARCH, the search for a handler continues by unwinding the stack. Finally, if the exception filter evaluates to EXCEPTION_CONTINUE_EXECUTION, the exception is dismissed, and control is returned to the point where the exception occurred, if possible.

Systematic Search for an Exception Handler



When Microsoft Windows NT *encounters an exception while the CPU is in user mode, its exception dispatcher systematically searches for a handler to deal with it. If none is found, it invokes the kernel default, which terminates the process.*

Increasingly Complex Tests

We created three increasingly complex procedures to evaluate NT structured exception handling. The procedures are named Simple, Memory_Allocate, and FileCopy. They range in functionality from simple memory allocation to a three-file I/O routine with stringent error-reporting requirements.

The procedures were meant not to be full-fledged applications but to mimic ordinary routines found in software development projects. Our experiment modeled applications that gracefully recover from errors triggered by low-level routines.

To isolate the components of NT structured exception handling, we implemented each procedure several ways. The implementations produced identical results while using different technical approaches.

Two versions of each implementation were developed. The first, Error Free, executes without exceptions. It let us measure the performance overhead inherent to each approach. The second version, Staged Error, forces an exception to occur. It let us draw conclusions about the exception dispatcher and the frame-based exception-handling mechanism. The figure "Relationships Among Test Components" illustrates the relationships among procedures, implementations, and versions.

How the Implementations Work

Our None implementation provides error checking without structured exception handling. None is a baseline that illustrates the architecture of non-exception-handling programs. It uses IF...THEN...ELSE constructs and passes errors as variables on the program stack. None does not use GOTO statements, and each function contains one entry point and one exit point.

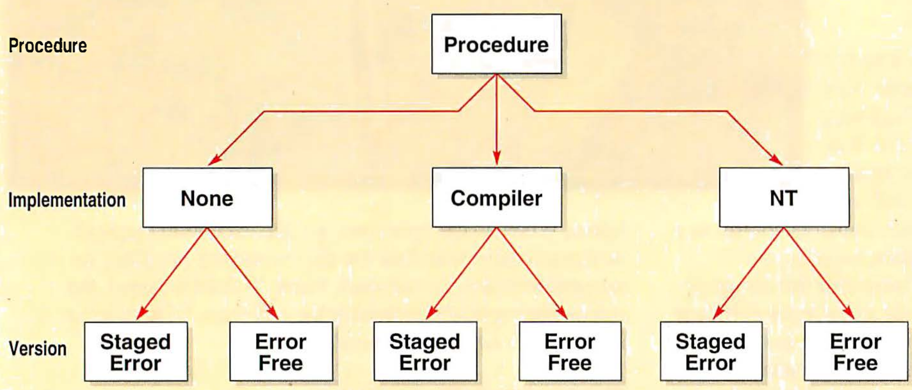
To isolate the exception dispatcher (the operating system) from the frame-based exception handler (the language/compiler), we needed a frame-based handler that didn't invoke the dispatcher. Our search for a language-only exception handler led us to an ANSI C implementation written by Jonathan Amsterdam (see "Taking Exception to C," August 1991 BYTE).

Amsterdam's code, the basis for our Compiler implementation, uses several macros to store a linked list of stack frames that are PUSHed and POPped onto the program stack. The macros are used as follows:

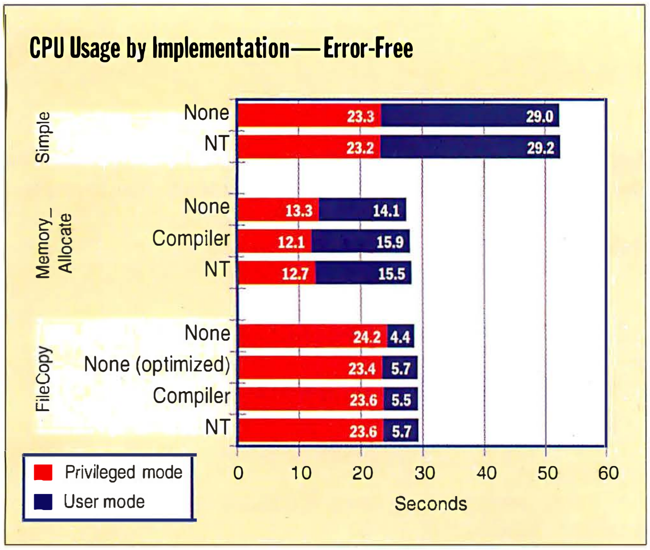
```
/* This is a C macro. */
WITH_HANDLING
{
/* Code goes here. */
}
/* This is another C
/* macro. */
ON_EXCEPTION
{
/* Error-handling code
/* goes here. */
/* This is a C macro,
/* too. */
} END_HANDLING
```

A program raises an exception by calling the `raise()` function. This implementation supports nested exceptions and locates the correct handler by unwinding the

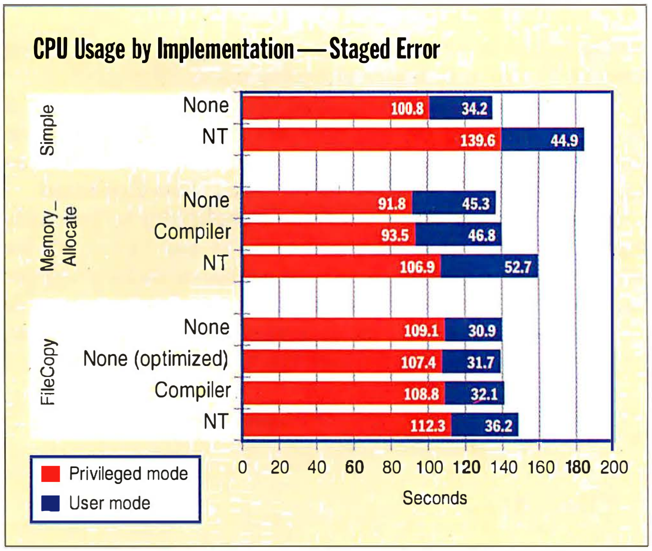
Relationships Among Test Components



The relationship among the procedures, *implementations, and versions used to test Windows NT structured exception handling.*



When we ran the test *procedures in their Error Free implementation, CPU performance was barely affected.*



When we ran the test *procedures in their Staged Error implementation, CPU performance was affected dramatically.*

stack. It stores exceptions as global variables; they are passed as variables on the program stack when `raise()` is invoked.

Amsterdam documented several flaws in his solution. However, we did not select this approach for its robustness, but because it is frame-based, can be implemented in ANSI C, and resembles the NT implementation in syntax and method.

Our NT implementation uses NT structured exception handling. We tested both kernel- and user-defined exceptions.

The Simple Procedure

The Simple procedure's primary purpose is to provide performance data. It's straightforward: No I/O calls or error structures are passed on the stack. It was trivial to write, ensuring that any performance overhead brought about by NT structured exception handling would be easy to observe.

Simple consists of one function that allocates 3 bytes of memory using the standard C library routine `malloc()`. It then copies a two-character string to the returned pointer. If `malloc()` fails, the function reports an error.

Simple has two implementations, None and NT. In the None implementation, the value `malloc()` returns is checked with an IF...THEN...ELSE statement. In the NT implementation, the program assumes that `malloc()` succeeds and performs `strcpy()` without checking the return value. If `malloc()` returns a null pointer, an ACCESS_VIOLATION exception occurs during the `strcpy()`.

Memory_Allocate Procedure

We designed Memory_Allocate to get a close look at the frame-based exception handler and the exception dispatcher. By comparing the Compiler and None implementations, we gained insight into frame-based exception handlers. By comparing NT and Compiler, we gained insight into the kernel dispatcher.

Memory_Allocate is functionally equivalent to Simple, but its error-reporting scheme mimics the approach used in software libraries. Typically, a library routine informs the invoking function when an error occurs but lets the invoking function determine the appropriate course of action. Library routines seldom directly inform you of errors.

Memory_Allocate consists of two functions: `Do_test()` invokes a homegrown memory allocation routine, `our_malloc()`, which in turn makes calls to the Win32 API. The staged error occurs in `our_malloc()`; the error code and description are reported in `do_test()`.

Memory_Allocate's None resembles Simple's None implementation; `do_test()` uses an IF...THEN...ELSE statement to test the value returned by `our_malloc()`. The Compiler and NT implementations raise user-defined exceptions if an error occurs in `our_malloc()`. The exceptions are handled in `do_test()` (see the listing on page 322).

FileCopy

FileCopy is the most complex procedure. Simple and Memory_Allocate provide lots of performance data, but they are too algorithmically simple to show how structured exception handling affects source code readability. FileCopy is much more arduous.

In our research, we noticed the terseness of error messages displayed by exception handlers. We decided that FileCopy's messages must provide the error code, the action being performed, and the name of the object causing the error. For example, if file X does not exist and is mistakenly opened for reading, you get the error message "Error 2 occurred while opening file X."

We also wanted plenty of LOOP and IF...THEN...ELSE constructs to test whether structured exception handling gracefully backs out of errors that occur deep within a program. We reasoned that by nesting a series of IF...THEN...ELSE statements in which each ELSE block contains some kind of cleanup code, we would witness the benefits of structured exception handling.

FileCopy reads the contents of one file and outputs alternating lines to two other files. Allocating and deallocating buffers, opening and closing three files, and looping to copy data guarantee complicated logic and tedious cleanup. As in Memory_Allocate, we required that exceptions be handled by the invoking function rather than the offending function.

The None implementation of `filecopy()` is written as one function. The exception checking and correction logic are complex and difficult to follow. An exception structure, passed on the program stack, can be populated from seven different places

within `filecopy()`. In each exception condition, a significant amount of code is dedicated to freeing resources.

After writing None, we realized that nobody would write it as we did, since many C programmers dislike rigidly structured programming. Consequently, we created a more realistic non-exception-handling implementation called None-Optimized.

None-Optimized improves None's readability by two techniques. First, file routines (e.g., `fopen()` and `fread()`) are wrapped, user-written functions. The parameter list for a wrapper function includes the parameter list for the corresponding file function, plus a pointer to the exception structure. For example, `fopen()` is wrapped in the user-function `file_open()`:

```
FILE *file_open(char *fname, char *type,
        ExcStruc *es)
{
  FILE  *f;

  if((f = fopen(fname, type)) == NULL)
  {
    es->code   = errno;
    es->Action = OPENING;
    es->Object = fname;
  }
  return f;
}
```

Second, a macro containing a GOTO statement is used to disguise the plethora of IF...THEN...ELSE statements—for example,

```
#define   Execute(A)     A;if(es->code)
      goto cleanup;

if((buf = malloc(BUFSIZE)) != NULL)
{
  Execute(in  = file_open(infile,  "r",es));

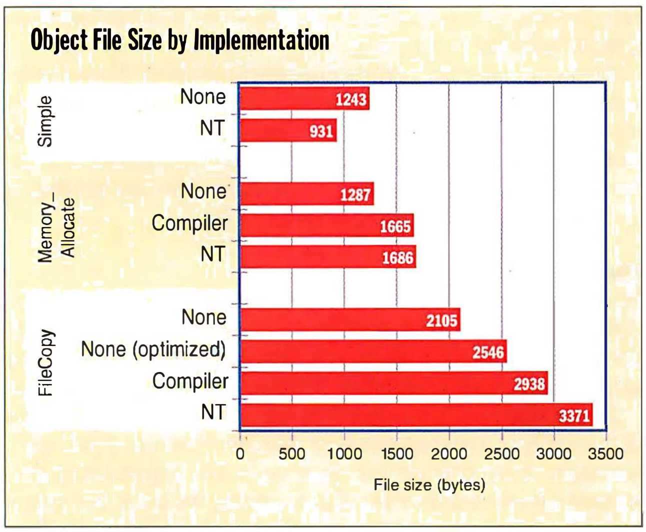
/* Start the copy code. */
cleanup:
/* Free memory, close files, etc. */
#undef Execute
```

`Execute(A)` hides the IF...THEN...ELSE statements associated with `fopen()`.

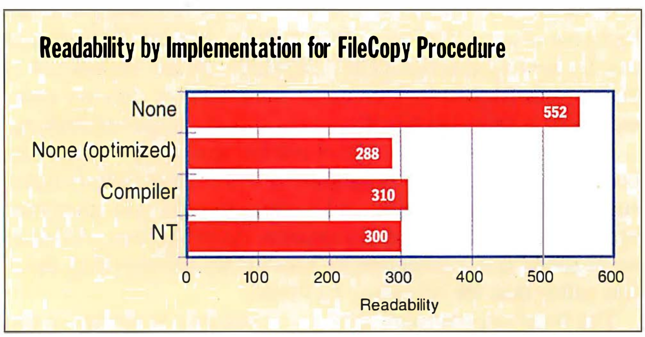
Compiler and NT also use wrapper functions. However, instead of passing an error structure on the stack, they raise exceptions. In Compiler, this entails populating a global exception structure and invoking `raise()`. The NT implementation is similar, but it does not use global variables. Here's the `fopen()` wrapper function for the NT implementation:

```
FILE *file_open(char *fname, char *type)
{
  FILE   *f;
  static DWORD   exceptionArguments[3];

  if((f = fopen(fname, type)) == NULL) {
    exceptionArguments[0] = (DWORD) errno;
    exceptionArguments[1] = (DWORD) fname;
    exceptionArguments[2] =
         (DWORD) OPENING;
  RaiseException(100, 0, 3,
      exceptionArguments);
  }
  return f;
}
```



The smallest object files *were created by the Simple procedure; the largest was created by FileCopy.*



Structured exception handling *improves source code readability because exceptions and wrapper functions reduce the nesting depth. The ratings here represent a metric comprising such concepts as complexity, maintainability, and reliability.*

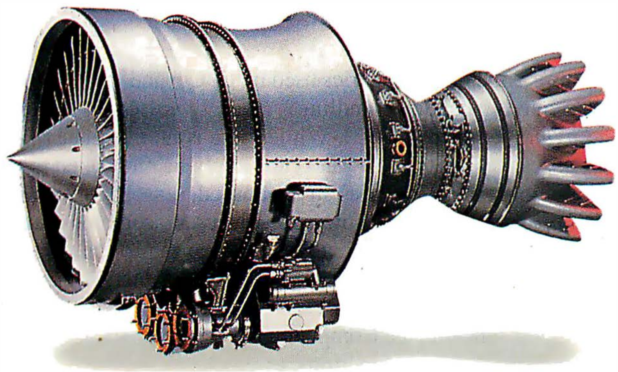
Test Environment

We ran our experiments on a stand-alone IBM PS/2 Model 95 with 16 MB of RAM running Windows NT, March 1993 beta. We wrote all programs in Microsoft C 7.0 for the Win32 subsystem. We used PView, NT's process viewer utility, to determine the amount of CPU time the main thread of execution used and the percentages of CPU time spent in privileged and user modes.

To measure program readability, we combined lines of code, number of functions, and nesting depth metrics. We determined lines of code by counting C statements and excluding comment lines and lines containing a single bracket. We determined nesting depth by counting the number of statements nested inside each function and taking the maximum.

Performance Analysis

When exceptions don't occur, implementation only slightly affects performance (see the figure "CPU Usage by Implementation—





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Partial code *illustrating the NT implementation; the Compiler implementation is similar.*

```
void do_test()
{
  try {
    buf = our_malloc(FORCE_ERROR ? 100000000 : 3);
    strcpy(buf, "ok");
  }
  except (theException = GetExceptionCode()) {
/* Check error code and report error. */
  }
}

void *our_malloc(size_t size)
{

  HLOCAL  memhandle;

  if((memhandle = LocalAlloc(LMEM_FIXED, (UINT)
       size)) == NULL) {
    RaiseException(GetLastError(), 0, 0, NULL);
    return NULL;
  }
  else
    return LocalLock(memhandle);
}
```

Error-Free"). The None implementation consistently outperforms Compiler (2.1 percent faster) and NT (0.2 to 2.9 percent faster) because it doesn't incur the overhead of saving the stack frame. This registration penalty is about the same for both Compiler and NT, which differ by less than 1 percent.

When an exception occurs, implementation significantly affects performance (see the figure "CPU Usage by Implementation—Staged Error"). Again, None is fastest, followed by Compiler and NT. Most startling is the NT implementation's poor performance—it executes 6 percent to 37 percent slower than None.

This performance degradation has two causes: the frame-based exception handler and the exception dispatcher. The frame-based exception handler imposes a 1 percent to 2 percent performance penalty, evidenced by comparing the None and Compiler implementations. Compiler and NT incur the delay of unwinding the stack frame and locating the appropriate exception handler. NT takes the most CPU and (more important) privileged-mode time. We believe this increase reflects the invocation of the kernel dispatcher. Compiler never invokes the kernel exception dispatcher; thus, it executes 6 percent to 14 percent faster than NT.

The differences in execution time between NT and the other implementations are primarily due to the increased time spent in privileged mode. In other words, the kernel dispatcher is the primary cause of NT's sluggish performance.

Size and Readability

In the Simple procedure, an IF...THEN...ELSE construct is matched head-to-head with a `try-except` construct. The IF...THEN...ELSE produces a larger object file, implying that `try-except` generates tighter code than IF...THEN...ELSE (see the figure "Object File Size by Implementation"). But the more complex procedures require wrapper functions and code to populate the exception structure. The NT implementations of Memory_Allocate and FileCopy produce the largest object files.

There are no appreciable differences in executable file sizes. We attribute this to the simplicity of our test programs.

Determining source code readability is subjective (see the figure "Readability by Implementation for FileCopy Procedure"). For brevity, we wove the concepts of complexity, maintainability, and reliability into a single metric, computed as follows:

```
Readability  = Lines of Code/Function *
      Maximum Nesting Depth *
      Number of Functions
```

This is a melding of metrics used by Q. Cui and J. Gannon ("Data Oriented Exception Handling," *IEEE Transactions on Software Engineering*, May 1992). While there is no evidence that these metrics are independent (and can simply be multiplied together), combining them provides an unadorned, reasonable standard for comparing readability among the different implementations.

Structured exception handling improves program readability primarily because exceptions and wrapper functions significantly reduce the maximum nesting depth. Rather than one large complex function, the Compiler and NT implementations produce many small, simple functions.

None-Optimized is the dark-horse implementation. It edges out NT in readability, but its complexity is not reflected in our metric. The macro is subtle, making None-Optimized difficult to maintain. Even so, None-Optimized proves that complex error handling can be implemented without exception handling in roughly the same amount of code.

We encountered a substantial learning curve in programming structured exception handling, partly due to the lack of documentation and examples. The biggest hurdle was orienting our thinking to design in terms of exceptions.

Mixed Conclusions

NT structured exception handling is no panacea. It fails to provide major benefits in execution time or compiled program size. Our data shows that the kernel-exception dispatcher imposes a significant performance penalty whenever it is invoked. Structured exception handling improves source code readability. But a language-based exception-handling implementation or a cleverly designed C program provides comparable improvements.

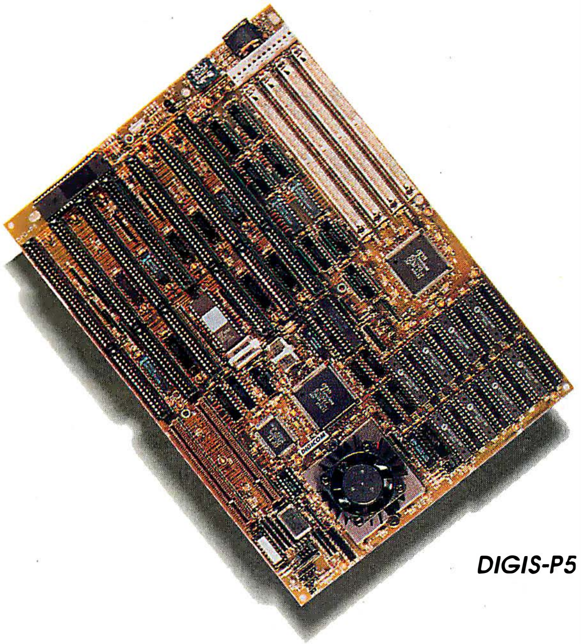
NT exception handling has one capability that cannot be duplicated in vanilla C or compiler-only implementations: kernel-defined exceptions. Without an operating-system implementation of exception handling, there is simply no way to recover from hardware traps or math and memory errors.

Our test environment could not duplicate the subtleties found in a large software development project. The real proving ground for structured exception handling is an environment in which several modules and exceptions interact. For example, if your applications are prone to memory errors, use NT's structured exception handling. There is no alternative. But since truly robust exception handling is an integral part of software design, you'll find that trying to retrofit existing code is not worth the effort.

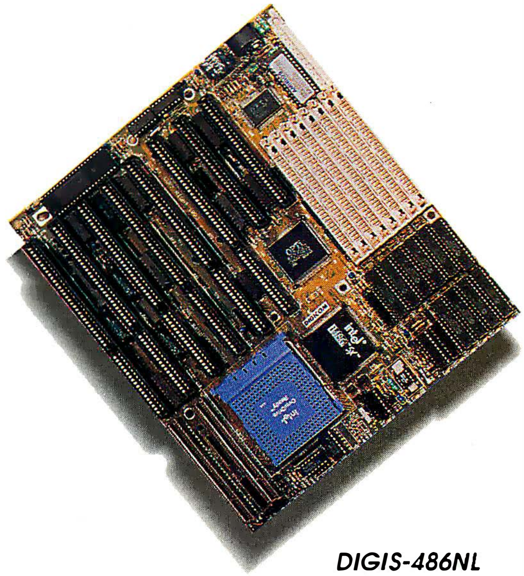
For your new development projects, structured exception handling has its benefits, but you will pay a price in performance. However, when exceptions occur, you may be willing to pay that price. Try it on a test project and judge for yourself. ■

Editor's note: *The program code SAR.ARC is available electronically. See page 5 for details.*

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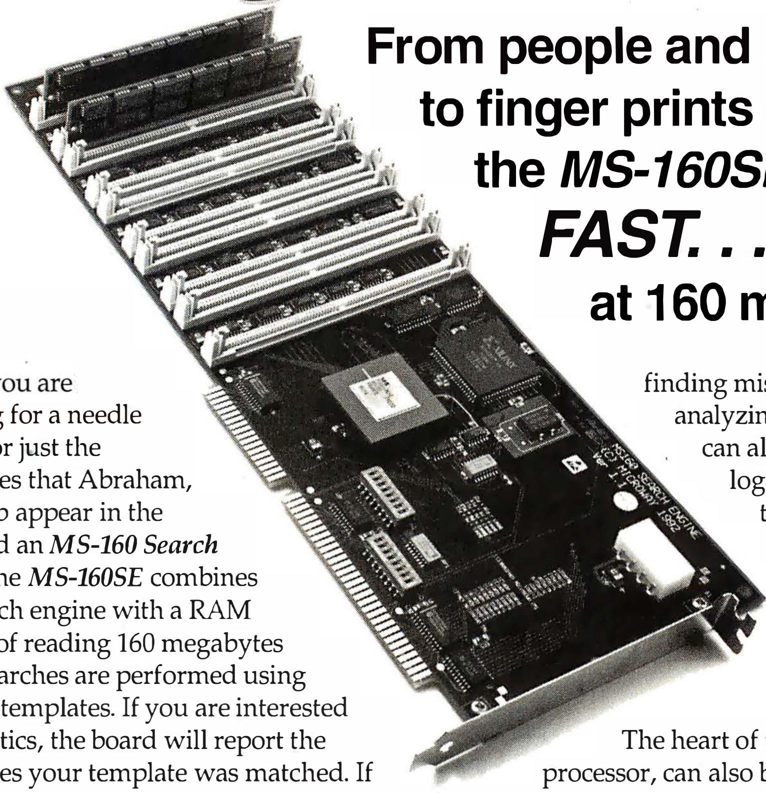
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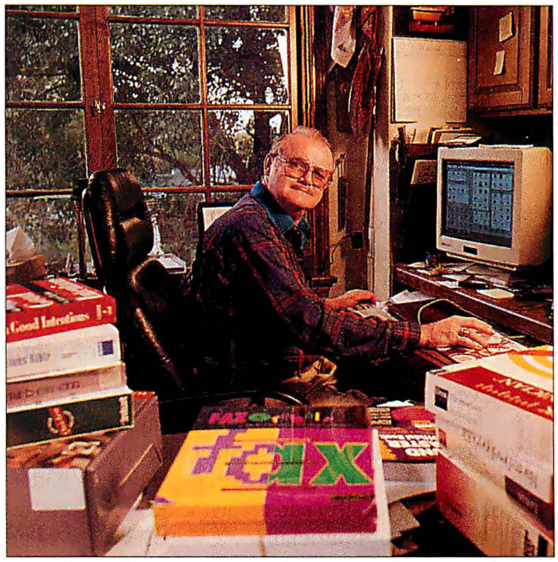
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In a busy month, Jerry attends a computer show in Brazil, changes his working locale, experiments further with OS/2, and looks at math programs

I have just come back from Brazil by way of Washington, D.C. Alas, all my time in Brazil was spent in São Paulo. John Dvorak and I went down for Fenasoft, a large computer exposition and fair. We flew from Los Angeles to Lima, Peru, and from there, supposedly, to São Paulo; but the São Paulo airport was socked in, so we landed in Rio. That turned out to be a good thing because we got to see Rio de Janeiro from the air, and that has to be one of the loveliest cities on this planet. I'm now determined to get down there when I have more time.

São Paulo, on the other hand, has the look and feel of Newark only six times as large—there are between 15 million and 20 million people—with Cleveland jammed in to provide a seacoast. It has the deadest river I have ever seen in my life, with, I swear it, streaks of red, black, and deep purple through the greenish-brown water. Not only don't birds land near that river, they don't even seem to fly over it. São Paulo smog and traffic make me appreciate a bad day in Los Angeles. However, it's also the place where most business—and nearly all computer business—is done in Brazil. It has the only building in the country capable of holding a big convention and exposition; and Fenasoft is *big*.

It may or may not be the largest computer convention in the world. That depends on how you define a computer convention—clearly, there are larger consumer electronics shows—and more important, how you define convention; because Fenasoft is more like a fair than like Comdex. Indeed, Dvorak and I instantly agreed that this is the way the West Coast Computer Faire ought to have been: big booths operated by giants like Microsoft and IBM, startups and users groups scattered throughout the show, lots of dealers and distributors selling discounted product like mad—there was a feeding frenzy for books and software—and huge crowds of people.

Just how many people isn't clear. The exposition hall is comparable in size to the main hall of the Las Vegas Convention Center, and it was considerably more crowded than that hall is during Comdex. On the other hand, Comdex in Las Vegas has more than one large hall. Meanwhile, in the Brazilian culture it's traditional to use superlatives. John Dvorak and I were each given a number of different attendance estimates, some clearly impossible. Mostly, the attendance depends on the turnover: how many people come for just a couple of hours, to be replaced by newcomers? I do know that I counted 220 people a minute entering at the main gate, and this at two different times of day; if they sustained that rate 10 hours a day (the hall was open late into the night), they'd have a really big show. In any event, it's large enough to count as a world-class computer exposition.

The crowds were mixed. Brazilian professionals tend to wear neckties with or without jackets, and I'd guess something like a quarter of the visitors had ties. São Paulo counts as the second-largest Japanese city in the world—only Tokyo has more Japanese—and there were a fair number of Japanese among the crowds, virtually all of them students or professionals. Like

early Comdex shows, there were few professional women, and most of them were exhibitors. That's going to change.

Brazil has a highly stratified society. One way that stratification is preserved is that the public universities are excellent, and admission is through academic merit. But the public lower-grade schools are universally thought rather poor, so admission to the universities is largely confined to graduates of expensive private schools. A university education is pretty well required for entry into the professions and is of great advantage in business.

> **Computers were both expensive and rare in Brazil until recently. This is because they had market-reservation laws: you could own and use only Brazilian-made computers. If the police caught you using an IBM or Apple machine, they confiscated it, and it might end up on the desk of a bureaucrat.**

Computers were both expensive and rare in Brazil until recently. This is because they had market-reservation laws: you could own and use only Brazilian-made computers, and if the police caught you using an IBM or Apple machine, they confiscated it. Like as not, your machine would (quite legally) end up on the desk of a bureaucrat or politician.

That all ended a couple of years ago, and the floodgates opened. There's still a high tariff on computers, but there's also a well-developed system of smuggling. One Brazilian journalist told me, "Smugglers are very serious people here. They even give warranties and provide technical support." Thus, the computer revolution is coming to Brazil—and that will have a profound effect on the social structure. After all, these little machines don't *care* where you learned to use them, and indeed, given that the universities haven't had access to small computers and don't have many professors who are familiar with them, it's likely that you'll learn to use a computer somewhere other than in a university.

The saying goes, "God made men, but Sam Colt made them equal." One of Pournelle's laws is that computers neither know nor care about your age, sex, color, or where you learned to use them. They do care a lot about talent and ability.

Communications from Brazil weren't easy, but both Dvorak and I managed. Since we've each done books on computer communications—alas, his was for sale in both English and Portuguese at the show, but there was no trace of mine in any language—it was inevitable that neither of us would give up until we had established E-mail connections. John got his first. The only machine he carries is a Gateway HandBook, and he uses some odd shareware communications program. He also carries an acoustic coupler, which allowed him to use the phone in the press center at the convention site. I didn't have an acoustic device with me, and I preferred to do my minor telephone surgery in the privacy of my hotel room. In the future, I'll take an acoustic coupler.

I had both a Gateway HandBook and a Gateway Nomad 486. I often carry a Supra modem, but this time I had the Macronix MaxLite 144. The MaxLite 144 is about the smallest full-featured fax modem you can carry, not a great deal bigger than the 9-V battery it runs on. (There's also an AC converter, which is as well because the battery doesn't last all that long; I once got less than an hour.)

I never did get connected to BIX or GEnie from Brazil, but I did manage MCI Mail, once with Procomm Plus 2.0, and once with the terminal program you get with Windows 3.1. It wasn't easy, and it required considerable mucking about with modem initializations and several wasted phone connections at overseas rates; it's very frustrating to get locked on at international rates and still be unable to communicate. The key is to call a number you know works with error correction and set your modem with AT X commands so that it ignores the dial tone and connects blindly after you dial. If you don't get an error-correcting lock, hang up quickly.



The various modem commands—well over a hundred—are explained very well in the MaxLite 144 manual. I've looked at a lot of modem manuals, and this is one of the clearest. Calling from Brazil isn't a fair test of a modem. Calling from the Bellevue Hotel in Washington, D.C., is fair, but severe: Washington in general, and the Bellevue in particular, seem to have about the worst phone connections in the U.S. You simply cannot manage communications without an error-correcting connection; moreover, 9600 bps is nearly impossible, while a 2400-bps connection requires so many correction retries that it's effectively slower than a straight 1200 bps on a clean line. The MaxLite 144 sometimes needed several tries, but I did get connected to MCI Mail, BIX, GEnie, and my home system using Procomm Plus 2.0.

I am now familiar with three major manufacturers of modems: USRobotics, Supra, and Macronix. In overall performance, I rank their products in that order. The USRobotics Courier will establish error-correcting connections quicker and easier than the other two modems, and it sometimes will manage communications after a fashion over noisy lines without error correction. On the other hand, it's too big to carry in your briefcase, and pretty big for checked luggage. USRobotics Couriers are the most upgradable; they are offering a "when available" upgrade to the emerging 28,800-bps standard for $99.

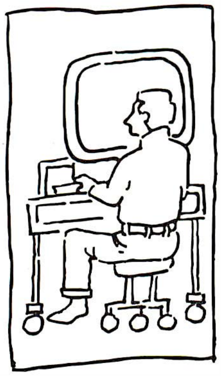
I had slightly less trouble with the Supra modem than I did with the MaxLite 144; that is, it took an average of four tries to get an error-correcting connection to Tymnet using the MaxLite 144, and only three to get an error-correcting connection to the same line using the Supra modem. On the other hand, the Supra modem is larger than the MaxLite 144: not so large that you can't get it into a carry-on bag, but large enough; and it won't run off a battery, so you have to carry the adapter as well. I stuff the MX power supply in checked luggage and carry the MaxLite 144 with a battery in my computer case, where it's small enough not to be noticed.

The bottom line is that I could and did rely on the MaxLite 144 for my communications, and it did the job. It's small, handy, and neat, and it comes with decent fax modem software and excellent manuals. Recommended.

I'm in a dither over computer furniture. I recently rearranged my office for the first time in four years, and as part of that I wanted to rethink my workstation. Since I spend much of my life sitting here, my chair and computer furniture are extremely important to me.

My first requirement is a big screen (I currently use a Nanao FlexScan T560i)

about 30 inches from my nose and precisely at eye level with my head in a comfortable position. Second is keyboard height: I like my keyboard where I can reach it without strain as I rest my elbows on the chair arms. Just about as important is a good place for a mouse. Third, there *must* be flat table space all around, where I can pile software, press releases about products I'm writing about, books I am copying from, maps, character sketches, notes for scenes, and so forth. It can be anywhere, but I really like to have some space dead in front of me.



Fourth, I need places to put auxiliary equipment: stereo speakers, a DAT (digital audiotape) drive, the USRobotics external modem, an external CD-ROM drive, an external WORM drive, and my little pocket tape recorder I use to dictate notes during my daily walk and its transcriber; that sort of thing. Fifth, I need legroom, since I can't sit in the same position for very long.

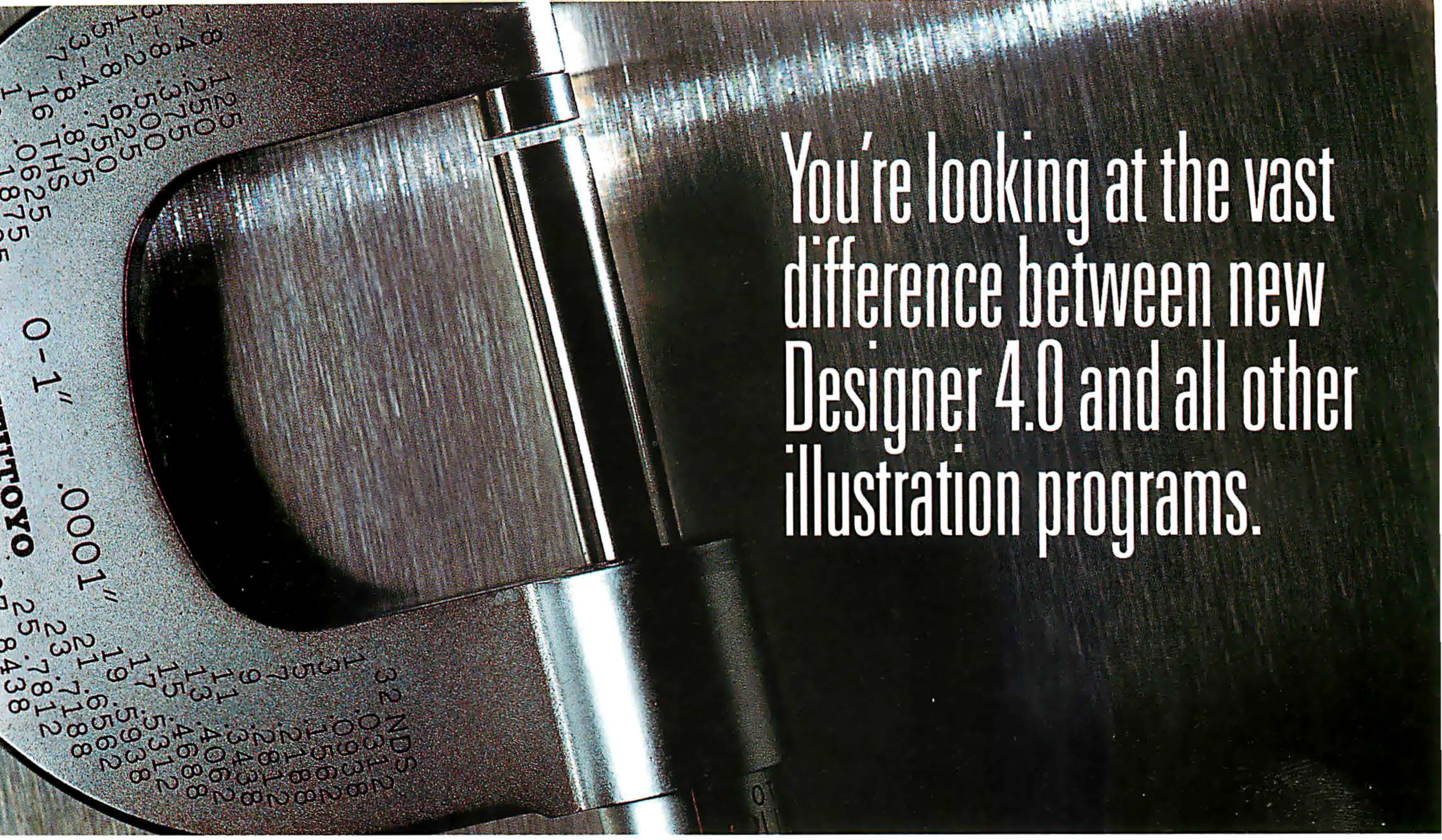
For the past few years, I've used a computer table I found at Builder's Emporium. It's 4 feet by 2 feet. It has a retractable keyboard drawer with a raised mouse platform, and you can see it in the photo of me. It had problems. I had to raise the height of the whole thing (I attached heavy-duty casters) to get the keyboard high enough. It put the screen closer than I like. The worst thing was that there's no flat surface space between the screen and the keyboard, so I have to turn my head to see what I'm working on. Still, it worked well enough to let me turn out a number of books, including *Prince of Sparta*, *The Children's Hour*, *Fallen Angels*, *The Gripping Hand*, and several others, as well as these columns and a bunch of other stuff. It wasn't perfect, but it was good enough.

Alas, when I shifted the office around (there's a good reason having to do with heat flow), there was no room for that big table at my new location. Time to rethink the entire situation.

One choice was the Forminco line, which you may have seen at various computer shows: IBM often features Forminco workstations at their OS/2 Test Drive Centers. You'll remember if you've seen them: they are large black and chrome open framework units on casters. When we set one up here, Mrs. Pournelle referred to it as "the condor cage," no bad description if said affectionately.

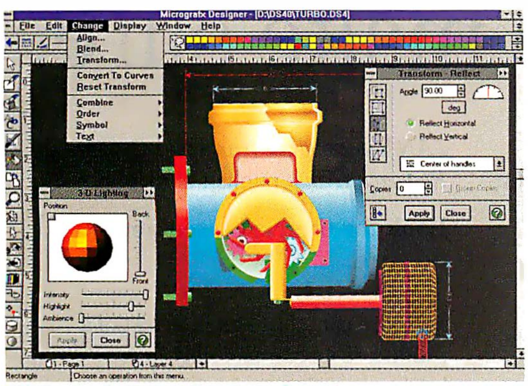
The Forminco units score high on keyboard height and placement: you can adjust that easily to almost any position you like. Same for screen placement: the screen is on an adjustable stand of its own, so it doesn't rest on a desktop computer. Moreover, if you use a tower machine (I do), there's lots of flat surface where the desktop would have gone. (There's also a system for supporting a desktop machine on its side alongside the workstation, thus more or less converting the desktop to a tower.)

The legroom is great. There's an ingenious placement of the mouse, and Forminco makes (included with the workstation but also available separately) the Mouse Arena, an odd-looking but extremely effective combination mouse pad and stand with a wrist rest and a gizmo to hold the



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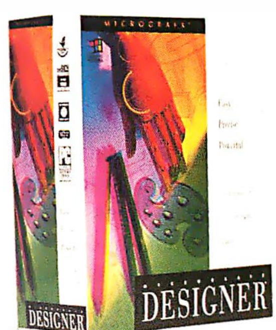
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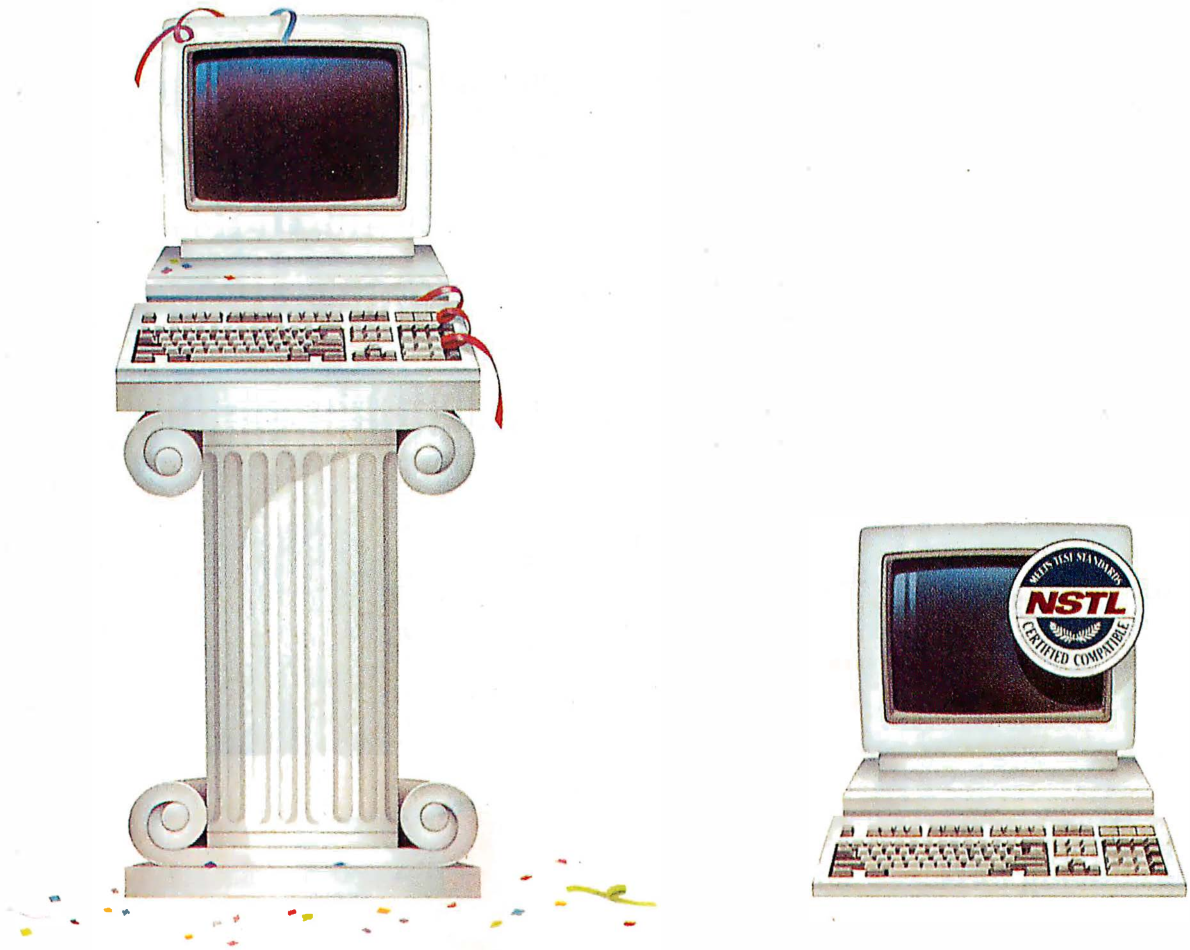
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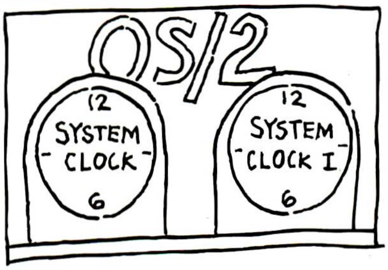
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mouse tail out of the way. If you do much mousing around, you ought to look into this. The wrist rest really works.

There's also a built-in padded wrist rest as part of the keyboard support, and it's really neat. I grew up working with typewriters, and we never thought of wrist rests. I use chair arms for more or less the same purpose. However, my partner Larry Niven likes wrist rests, and I confess I quickly got spoiled by the Forminco keyboard stand when I set it up for trial.



The Forminco system has a left-handed stand that you can put either the mouse or your coffee on. There's a weird stand for the telephone and a removable copy holder. Everything is removable and adjustable. All told, the Forminco system is handsome, well designed, and comfortable to work at.

Where it loses points is efficient use of volume. It needs some kind of shelf attachment to provide a place for auxiliary equipment. In particular, it has no drawer for labels and calculators and the other stuff I use a lot. It's also just large enough to be a problem for my new location. If I adopt it, I'll need to do some serious rearrangement, and what with upcoming trips, I can't get to that for a couple of weeks or more.

Just at the moment I've done a kludge, with my screen on a cabinet and the keyboard on a funky old sewing-machine table. Very longtime readers will recall this is the arrangement I had for Ezekial, my old machine who's now on exhibit in the Smithsonian. I may keep that: after all, I did a million words or more with that arrangement, so it must work pretty well. On the other hand, I already miss the comfort of the Forminco condor cage and its neat ergonomic features. We'll see when I get back from Sweden. Meanwhile, if you do a lot of work sitting in front of a computer, you should look into the Forminco line of ergonomic computer workstations.

I'm continuing to experiment with OS/2, and I'm getting frustrated. It's so useful I want to adopt it; but then I run into some new problem.

Example: I found the OS/2 screen displays intolerably slow. This turns out to be an ill-chosen default setting: go into the OS/2 systems setup folder, deactivate animations, and things will go much faster.

Another problem is disk space. I have OS/2 on an IBM PS/2 Model 77 with 8 MB of memory. The hard disk is partitioned into an 80-MB C drive and a 125-MB D drive. You might think that would be enough; but it's not, at least not for me, and the result could have been a disaster.

Now granted, I have to put a lot more stuff on my hard disk than most. I'm forever trying out programs, and since I *use* stuff rather than do formal evaluations, anything I'm going to write about has to stay around long enough for me to get used to it. In addition, OS/2 is wonderful for communications, but that means that some days people send me enormous files. I function as a system operator on both BIX and GEnie, so sometimes I download a bunch of stuff from there. E-mail accumulates.

The result is that the PS/2's disks get full, and I don't notice it. This isn't a big problem as long as I am running DOS applications; but it's different if you want to run Windows programs.

Last night, my son Richard and I decided to play around with the DeLorme Mapping Street Atlas USA. It's wonderful. If you don't have it, get it. Amazing detail, not only just about every street in the U.S., but fire roads in Los Angeles and even High Sierra trails. You can cut and paste into CorelDraw with it, too, and print from that.

The DeLorme atlas is a Windows program on a CD-ROM. Richard, who isn't familiar with OS/2 but uses Windows a lot, opened the Windows OS/2 program manager and installed it easily enough; except that when we open the program manager, there comes a message about NAVPOPUP.EXE being unavailable. I don't know what that is, but I've got used to having this error message. It doesn't seem to do any harm, except that I have to tell the machine everything is OK before it will do anything else, and that's annoying if I'm trying to get something done in a hurry.

Alas, for me OS/2 has been full of oddities like that. I have two copies of the system clock, named System Clock and System Clock:1. Every attempt I have made to eliminate the superfluous copy has failed. There's probably a way to do it, but I sure don't know what it is, and neither does an IBM guru who wrote a book about using OS/2. It seems this is an essential file, and for your own protection, OS/2 won't let you eliminate any essential files—even if you have somehow inadvertently managed

to duplicate one of them.

Anyway, we installed the DeLorme atlas, whereupon I got a message that the disk partition containing the file SWAPPING.DAT had insufficient space, and I had a problem, and I must not ignore this message. The default thing to do was close the program. That seemed reasonable, so I tried it, whereupon the computer went off into the land of lost bits and stayed there until I turned it off. Ctrl-Alt-Del did nothing interesting. It was hardware reset time.

It wasn't quite the infamous Windows UAE (unrecoverable applications error). When the system came back up, I did the same thing again and got the same error message; it gives three choices, and any but the default choice lets the machine recover. The default, though, turns it into a UAE. Beware.

I think my real problem with OS/2 is that I installed it during a period when it wasn't entirely stable, and there seem to be remnants of different versions in my system.

A search through the OS/2 documents reveals remarkably little about SWAPPING.DAT. I wanted to go in and set aside considerably more space for that swap file; this wouldn't be as efficient as the IBM dynamic reallocation, but it would sure make my life simpler when the disk was getting full. Alas, the printed manuals aren't too helpful, and neither is the Master Help Index.

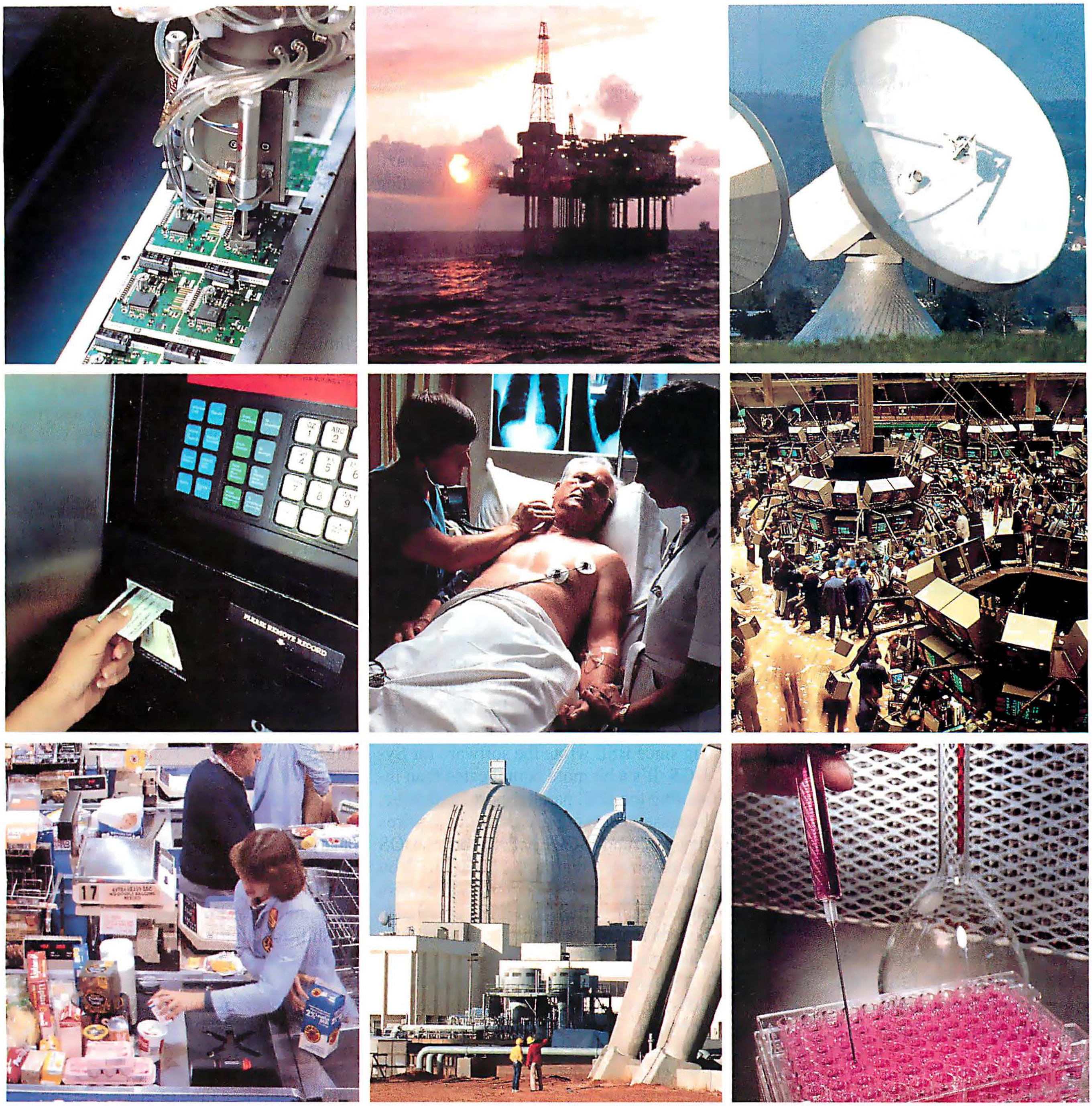
However, if you open an OS/2 window (which gives you a command-line session) and type HELP SWAP, there appear all kinds of useful information on the swap file. By editing CONFIG.SYS, you can set the size of the swap file or cause the system to warn you when file size on that disk partition is getting low. Once again, it's typical of OS/2 to have a nifty feature like that and then hide it from you.

Of course, what I really need is more memory. Eight megabytes aren't really enough for a multitasking system running both DOS and Windows applications, and memory is cheap. (Or it used to be; just now there's a panic again, but it will probably be over by the time you read this.) Once I have more memory, I'll install Stacker—there's a perfectly good OS/2 version—to make more room on the hard disk.

Next I would like to attach a good optical drive to the PS/2; that way, I can migrate a lot of programs I don't use often and still have them available at need. I've got a new Maximum Storage Duette dual-purpose WORM and read/write optical drive. It works fine with DOS, and if I can make that work with OS/2, I'll be in great shape. Report next month.

Meanwhile, I can report that OS/2 does Windows programs quite well, provided that you've got enough memory and disk space.

I think my real problem with OS/2 is that I installed it during a period when it wasn't entirely stable, and there seem to be remnants of different versions in my system. Several IBM OS/2 gurus assure me that my odd experiences are not typical. On advice from those gurus, I am about to use LapLink to send all my essential application files over to the Maximum Storage optical drive, reformat and repartition my hard disk, and start over. This will take a day, including reconfiguring OS/2 the way I want it, but they tell me it will eliminate a *lot* of the squirrelly things



that keep happening to me.

I do want you to note that I've stayed with OS/2 despite my problems. IBM OS/2 expert Dave Whittle (who was in Brazil with us) points out that he's been reading the column for years and recalls a number of problems I had with Windows. All true. And I'm told that there will be, about the time you read this, a true peer-to-peer OS/2 network as easy to set up and use as Windows for Workgroups. I sure hope so. Despite multiple annoyances that have had me tearing my hair out, there's a lot to like about OS/2.

The SyDOS Personal CD is the solution to the problem of how to install and use CD-ROM software where there's no CD drive. For instance, Richard at UCLA uses an NCR 3170 Windows laptop. A laptop is very convenient for a student, but there's a great deal of software on CD-ROMs that he could use. The Personal CD handles that nicely.

It's a self-contained unit about the size of a shoe box that connects to the parallel port. The software installs automatically from a floppy disk, about like the software for a BSE Flashdrive, which isn't surprising since BSE wrote the software for SyDOS. It's a bit more complicated than installing the BSE parallel-port Flashdrive, because accessing a CD-ROM requires that you run MSCDEX.EXE, but SyDOS has automated that installation, too. You can, if you have the memory, add buffers (the default is four, and 10 is optimum), but otherwise it's rare that you'll need anything but the default values.

Unlike the BSE Flashdrive, a CD-ROM drive needs too much power for battery operation, so you'll probably put this in checked luggage for trips. It's rugged enough to take that. It will also play CD audio records.

Obviously, this isn't as fast or convenient as a CD-ROM that works through the bus, but even that is changing. New developments in parallel-port technology are making that port as fast as a bus extension used to be. Even now, this sure beats the heck out of endlessly swapping floppy disks for big program installations. Recommended.

Stanford Graphics is so good I don't know where to start. From the title, you might guess that it's another drawing program; actually, it is one of the most powerful statistical-analysis and presentation management programs I have ever seen. It will take your data, massage it in myriad ways, and present it in over 60 graphics formats. Contour graphs, 3-D graphs, scatter plots—you name it, this will show it.

John Tukey, America's foremost statistical theorist, has always admonished his students to *look* at their data, not just run it through equations; two of his students, looking for new ways to do that, developed a program called MacSpin for the Macintosh. It encouraged you to play around with numbers, always the best way to learn. That was pretty good, but it was limited by what a Fat Mac could do.

Stanford Graphics isn't limited at all. It's also easy to install, passing the Lazy Reviewer Test. Richard had it up and running and was doing useful things with it without ever taking the shrink wrap off the manual. Richard spent last year doing political polling analyses for the American Enterprise Institute and got extremely familiar with Microsoft Excel, which he likes a lot. After an hour with this program, he's ready to abandon Excel and change to Stanford Graphics. For what he does, Stanford's spreadsheet is at least as good as Excel. Excel has a better macro capability, but on most other counts, Stanford Graphics wins hands down, and it also has much of the presentation building power of PowerPoint. Incidentally, Stanford Graphics can access data from Excel and most other standard sources.

Not only will Stanford Graphics do data analysis, it will let you tinker with the data. Change values on-screen to see what that does. What if 5 percent of the Anglo lower-middle-class Protestants who favor Perot shift to Clinton? What if we pitch our product toward the 30–35 age bracket instead of 7-year-olds? All spreadsheets will let you tinker, of course, but this makes it easy: just drag data points around with the mouse. It also encourages you to think about ways to present your information: think of this as a kind of electronic implementation of Edward Tufte's marvelous book *The Visual Display of Quantitative Information.*

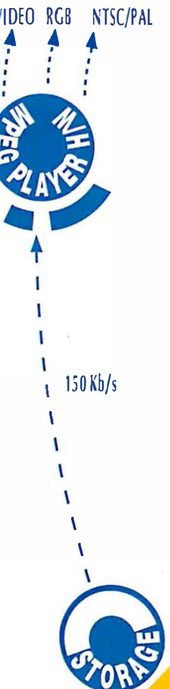
Stanford Graphics needs a high-end 486 machine (it will run on a 286 without a math chip, but you won't like it), but any good analysis program needs good hardware. I'll summarize this way: if I'd had a 486 with Stanford Graphics in the 1960s, I'd have been the greatest political scientist *and* operations research worker of the decade. If you do economics, business analysis, statistics, or almost anything that involves numerical data, you can't afford not to have this. Highly recommended.

Dr. T's Music Software has products for Amiga and Atari systems, and it's very good stuff. If you do much work with

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music, you need to know about this company. Record, edit, transcribe, print: a complete composer environment. Atari and Amiga don't seem able to move back into the mainstream of the computer revolution, but each has captured a pretty good niche. At the moment, Atari pretty well owns the popular music field, with Amiga its only serious rival. That could change as high-end PCompatibles move to multimedia, but so far it hasn't.

I don't have enough space to do Dr. T's software justice; just let me say that if you are serious about music, you'll want to know about it. I'm not musical, but Mrs. Pournelle is, and she's been impressed by it.

The Student Edition of Maple V is one of the best buys in the computer math program field. Unless you've got really high-end requirements, it will do all you'll ever want.

The math program wars continue, and there are now a number of excellent packages out there. There's a new-and-improved version of Macsyma, the original symbolic algebra program and still the most powerful of the lot, but others are catching up. One I haven't mentioned before is Maple V. The Student Edition of Maple V is one of the best buys in the computer math program field. Unless you've got really high-end requirements, it will do all you'll ever want, it's pretty easy to learn, and it works the same on Macs, PCs, and various workstations.

MathSoft continues to release their various handbooks. The latest is McGraw-Hill's *Theory and Problems of Electric Circuits*, a classic work translated to computer form. Mathcad's major strength is in the available specialized handbooks in almost every field: electricity, electronics, chemistry, materials science, mechanical engineering, and so forth, which make it very easy to do practical applications.

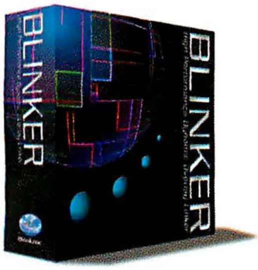
I can remember haunting the old ARPANET in order to use Macsyma, which was available only if you had an MIT ARPANET account. Now there are half a dozen excellent programs, each more powerful and with much better graphics capabilities than the old Macsyma: enough so that I can no longer keep up with which one is "best"; and that's not important anyway. The fact is they're all good enough, and any engineering or science student or professional who doesn't have one of these is at an enormous disadvantage. If you get familiar with any one of these, you'll be miles ahead.

If you do many computer presentations, you might want to know about PRO Presenter. This is a wireless infrared receiver that attaches to the mouse port (or the serial port that your mouse attaches to), a tiny transmitter clicker with two buttons, and software to make your computer think those are the left and right buttons of your mouse.

Since most presentation software can be set to run with mouse-clicks, once you set this up, you can walk around the room and control the presentation. It comes in a small simulated-leather case and weighs only a few ounces. Not something everyone needs, but it's convenient if you do happen to need it.

I don't usually recommend anything I don't use, but sometimes I get so used to something I'm reluctant to change, even when something "better" comes along. That's the situation with Ascend versus Arabesque ECCO. Ascend

How many memory management tools does it take to create a program?



Just one....

Why use a multitude of memory management tools when one will do? Introducing Blinker 3.0, a Windows™ linker, a royalty-free 286 DOS extender, a DOS dynamic overlay linker and a memory swap utility, all in one unique product. Now there is an easy way to maintain and enhance existing DOS systems and write new Windows programs. Compatible with virtually every popular PC programming language, including CA-Clipper®, Blinker 3.0 creates memory efficient programs in a matter of seconds. The result - increased productivity and lower training costs.

An intelligent memory management solution for DOS

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A 286 DOS extender with <u>no</u> <u>runtime</u> <u>royalties!</u>

Now everyone can afford to break the 640Kb DOS barrier! Directly access up to 16 megabytes of extended memory just as if it were conventional memory on any 80286 or above. Run multi-megabyte programs in protected mode in less than 256 Kb of conventional memory, solving low memory problems caused by network shells and other memory hungry TSRs. Boost program performance - all code and data is memory resident so there is no swapping to disk. Blinker 3.0 is fully compatible with the DPMI, VCPI and XMS specifications so your protected mode programs will run under Windows, DESQview™ and OS/2® as well as DOS. And Blinker 3.0 features a completely transparent compiler-independent VM system to access up to 64 Mb of virtual memory.



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Blinker 3.0 offers greater functionality than any other product, or combination of similar products on the market, for a fraction of the cost. You get the fastest link speeds available for DOS <u>and</u> Windows in one linker, plus industry standard .EXEs for compatibility with copy protection, anti-virus and compression software. Blinker 3.0 fully supports all versions of CodeView® and is just one 200Kb .EXE of highly optimized assembly code. What's more, there are no run-time royalties on any programs you create. Doesn't that sound too good to be true?! Then try it! With our 30 day money back guarantee you just can't lose!

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Circle 381 on Inquiry Card (RESELLERS: 382).

For More Information

For day-to-day tracking of contacts and notes and for organizing the countless snippets of information that flow in every day, try **Arabesque ECCO.** Available for $395 from **Arabesque Software, Inc.,** 2340 130th Ave. NE, Bellevue, WA 98005, (800) 457-4243 or (206) 869-9600. **Circle 1146 on Inquiry Card.**

I have a lot of time invested in **Ascend,** I like it, and it is pretty good at helping me sort out what's important and what isn't. The software alone sells for $199, or with the Day Planner, $299. It is available from **Franklin Quest Co.,** 2550 South Decker Lake Blvd., Suite 26, Salt Lake City, UT 84119, (800) 877-1814 or (801) 975-9992. **Circle 1147.**

The **Business Library** CD-ROM works on marketing research, real estate, and lots more stuff like that. It needs Windows 3.1, meaning it works with OS/2 2.1 but not 2.0. It sells for $59.95. Contact **Allegro New Media,** 387 Passaic Ave., Fairfield, NJ 07004, (800) 424-1992 or (201) 808-1992. **Circle 1148.**

The **DeLorme Mapping Street Atlas USA** CD-ROM has amazing detail on not only just about every street in the U.S., but fire roads in Los Angeles and even High Sierra trails. You can cut and paste into CorelDraw with it, too, and print from that. The CD-ROM for Windows sells for $169. Contact **DeLorme Mapping,** Lower Main St., P.O. Box 298, Freeport, ME 04032, (207) 865-1234. **Circle 1149.**

Forminco offers a line of **ergonomic computer workstations** that score high on keyboard height and placement, screen placement, legroom, and mouse placement. The handsome, well-designed, and comfortable furniture also features a padded wrist rest, a stand for the telephone, and a removable copy holder. Prices range from $199 to $449, depending on the options you want. Contact **Forminco,** 9610-A Ignace, Brossard, Quebec, Canada J4Y 2R4, (514) 444-9488; also, Sue Heckathorne, Boardroom Communications, Atrium Executive Plaza, 499 Northwest 70th Ave., Suite 118, Plantation, FL 33317, (305) 321-6334. **Circle 1150.**

The new-and-improved version of **Macsyma** for the PC, version 417.125 Delta 2 ($349), is still the most powerful symbolic algebra program of the lot. Contact **Macsyma, Inc.,** 20 Academy St., Arlington, MA 02174, (800) 622-7962 or (617) 646-4550. **Circle 1151.**

Small, handy, and neat, the full-featured **MaxLite 144** fax modem comes with decent fax modem software and excellent manuals. It is available from **Macronix, Inc.,** 1348 Ridder Park Dr., San Jose, CA 95131, (800) 858-5311 or (408) 453-8088, and costs $399. **Circle 1152.**

Dr. T's Music Software, 124 Crescent Rd., Suite 3, Needham, MA 02194, (800) 989-6434 or (617) 455-1454, makes **music software** that's as good as anything for Amiga and Atari systems. There's a complete composer environment that records, edits, transcribes, and prints, and a MIDI recording studio package for the Atari that's good. **Circle 1153.**

OS/2 2.1 is wonderful for communications. IBM's 32-bit operating system lets you run DOS and Windows in a true multitasking environment. Available from **IBM Corp.,** 1 Old Orchard Dr., Armonk, NY 10504, (800) 342-6672, it sells for $249. **Circle 1154.**

Procomm Plus 2.0 has some peculiarities, but it's still the communications program I use for nearly everything. The DOS version sells for $129; the Windows version for $179. Contact **Datastorm Technologies, Inc.,** 3212 Lemone Blvd., Columbia, MO 65201, (314) 443-3282. **Circle 1155.**

PRO Presenter is a wireless infrared receiver you can set to run with mouse-clicks and then walk around the room and control presentations. It comes in a small simulated-leather case and weighs only a few ounces. The price for the PC or Mac version is $99. Contact **Presentation Electronics, Inc.,** 4320 Anthony Court, Suite 1, Rocklin, CA 95677, (800) 576-9281 or (916) 652-9281. **Circle 1156.**

Space Quest V—The Next Mutation ($69.95) is a computer game with the latest antics of Roger Wilco, the janitor turned space cadet, as he saves the universe. The graphics are wonderful. Contact **Sierra Online,** 40033 Sierra Way, Oakhurst, CA 93644, (800) 326-6654 or (209) 683-4468. **Circle 1157.**

One of the most powerful statistical-analysis and presentation management programs I have ever seen, **Stanford Graphics** takes your data, massages it in myriad ways, and presents it in over 60 graphics formats. The price is $495. Contact **3-D Visions Corp.,** 2780 Skypark Dr., Torrance, CA 90505, (800) 729-4723 or (310) 325-1339. **Circle 1158.**

The **Student Edition of Maple V** ($99) is one of the best buys in the computer math program field, unless you've got really high-end requirements. It's pretty easy to learn, and it works the same on Macs, PCs, and various workstations. The Student Edition of Maple V is available from Brooks-Cole, 511 Forest Lodge Rd., Pacific Grove, CA 93950, (408) 373-0728. The full version of Maple V is available from **Waterloo Maple Software,** 450 Phillip St., Waterloo, Ontario, Canada N2L 5J2, (800) 267-6583 or (519) 747-2373. **Circle 1159.**

The **SyDOS Personal CD** solves the problem of how to install and use CD-ROM software where there's no CD-ROM drive. A self-contained unit about the size of a shoe box, the drive connects to your desktop or laptop PC's parallel port. It sells for $499 from **SyDOS,** 6501 Park of Commerce Blvd., Suite 110, Boca Raton, FL 33487, (800) 437-9367 or (407) 998-5400. **Circle 1160.**

does a far better job of keeping track of your goals and philosophies, but in the day-to-day tracking of contacts and notes and organizing the countless snippets of information that flow in every day, Arabesque ECCO is much better. Ascend grew out of a pen-and-paper system, and some of its roots show. ECCO was designed by computer people.

On the other hand, I have a lot of time invested in Ascend, I like it, and it is quite good at helping me sort out what's important and what isn't. I continue to use Ascend, but stay tuned; meanwhile, if you don't use one of these programs, you're missing something. A good time and task management system can change your life.

The CD-ROM of the month is from Allegro New Media. Allegro is the company formed when one of the founding partners of the Bureau of Electronic Publishing broke off to go it alone, and it's very much worth your while to get the Allegro catalog. This month's CD-ROM is a Business Library that includes *Business-to-Business Communications Handbook*, *Finance and Accounting for Nonfinancial Managers*, *International Herald Tribune Guide to Business Travel: Europe*, works on marketing research and real estate, and lots more stuff like that. It needs Windows 3.1, meaning it works with OS/2 2.1 but not 2.0.

The computer books of the month are Gordon M. Campbell's *System 7.1: The Complete Sourcebook* (Windcrest/McGraw Hill, 1993), a very good user-level work from installation to some quite advanced features, and Dan Gookin's *MS-DOS to the Max, Version 6* (Microsoft Press, 1993). I still don't recommend MS-DOS 6, because I greatly prefer Stacker and Quarterdeck's QEMM for file compression and memory management and Symantec's caching software; but, of course, MS-DOS 6 does work, and you get an awful lot for your money. If you do use it, Gookin's book is a good way to learn how to get the most out of it.

The game of the month is Space Quest V—The Next Mutation from Sierra Online. The latest antics of Roger Wilco, the janitor turned space cadet, as he saves the universe. It's a silly, mindless game, but Larry Niven loves it. He's got through two previous Roger Wilco games and is happily working through this one. The graphics are wonderful.

One minor correction: last month I made a reference to Chaplin's film *City Lights*. Mea culpa. I should have said *Modern Times*.

I'm out of space, and there's an enormous pile of new software and hardware left on my ready table. Next month, I'll look at some multimedia authoring programs; Stacker 3.1; more on OS/2 and optical drives; the latest and greatest from ATI Technologies, including their multimedia upgrade kit; and however much more of the pile I can get to. Now I'm off to Sweden, where they're giving me a birthday party. ■

Jerry Pournelle holds a doctorate in psychology and is a science fiction writer who also earns a comfortable living writing about computers present and future. Jerry welcomes readers' comments and questions. Send a self-addressed, stamped envelope to Jerry Pournelle, c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply. You can also contact him on BIX as "jerryp."

What's New Hardware



FAST X STATION ▲

A medium-resolution color X Window System station based on the Intel 960 RISC processor, the Hewlett-Packard (Santa Clara, CA) Envizex Model 15Ci ($2495) has 6 MB of RAM and 1 MB of video RAM. The 15-inch monitor shows 256 colors at resolutions of up to 1024 by 768 pixels with a 70-Hz refresh rate.

Phone: (800) 752-0900 or (415) 857-1501.

Circle 1064 on Inquiry Card.

DUAL-SPEED CD-ROM

CMS Enhancements' (Irvine, CA) CD-ROM drives for PCs and Macs (from $699) feature dual transfer rates of 150 and 300 KBps, average seek times of 280 ms, and 256 KB of data cache. The drives, available as internal or external units, are compatible with Multisession Photo CD, QuickTime, High Sierra, Mac HFS, ISO 9660, XA, and standard audio CDs.

Phone: (714) 222-6000.

Circle 1070 on Inquiry Card.

Texel's (Santa Clara, CA) internal DM-3028 ($499) and external DM-5028 ($599) CD-ROM drives provide a sustained data transfer rate of 335 KBps and an average access speed of 240 ms. PC- and Mac-compatible, each drive is Multisession Photo CD–capable and includes a 64-KB buffer, an automatic lens cleaner, and a dustproof door.

Phone: (408) 980-1838.

Circle 1071 on Inquiry Card.

NETWORK ON A CARD

A managed 10Base-T module for the INX 5000 intelligent wiring hub, the 10BT-MGR (from $2095) incorporates an on-board SNMP agent, making a separate network management module unnecessary. The 10BT-MGR, from Racal-Datacom (Boxborough, MA), has three 24-port cards, freeing slots for network expansion. The hot-swappable module includes automatic port partitioning, which isolates any port that's transmitting erroneous data; automatic polarity correction allows you to change the polarity without rewiring.

Phone: (800) 722-2555 or (508) 263-9929.

Circle 1067 on Inquiry Card.

MAC ACCELERATOR BOARD

The Tornado graphics board ($799) from Mirror Technologies (St. Paul, MN) provides on-board QuickDraw acceleration and 24-bit color on 21-inch monitors. Used with multisync monitors, the board provides on-the-fly resolution switching. An optional NTSC adapter lets you directly connect your system to your TV or VCR. An optional add-on board, ChargeCard ($599; bundled with Tornado, $1299) speeds some functions in Adobe Photoshop.



Phone: (612) 633-4450.

Circle 1068 on Inquiry Card.

COLOR MONITORS

From Radius (San Jose, CA), the PrecisionColor Display/20v monitor ($2199) is compatible with Macs and PCs. The 20-inch display shows two full pages at resolutions as high as 1152 by 870 pixels on Macs and 1280 by 1024 pixels on PCs. RadiusWare software lets you switch resolutions and bit depth on the fly. The unit has 75-Hz refresh rates and is MPR II compliant.

Phone: (408) 434-1010.

Circle 1072 on Inquiry Card.

The Flexscan F560iW ($1699), a 17-inch flat-square monitor from Nanao (Torrance, CA), provides a resolution of 1280 by 1024 pixels at a 76-Hz refresh rate. The energy-saving monitor includes ErgoCoat antireflective coating, WideView, and front-mounted controls built around a digital control system that stores information about the screen configurations and display modes that you set.

Phone: (213) 325-5202.

Circle 1073 on Inquiry Card.

ViewSonic (Walnut, CA) has upgraded its New Generation ViewSonic 15 color monitor ($599) to a "green" machine. The energy-efficient monitor conforms to the VESA power-savings management standard by powering down in three stages in direct response to the system's video-signal input. The flat-square display has a noninterlaced resolution of as high as 1280 by 1024 pixels.

Phone: (800) 888-8583 or (909) 869-7976.

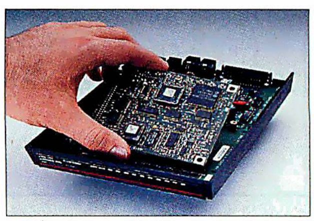
Circle 1074 on Inquiry Card.

TURBO-SPEED MODEMS

The Courier V.32 terbo modems (from $645) from USRobotics (Skokie, IL) support data rates of up to 19.2 Kbps and include the company's Adaptive Speed Leveling protocol for 21.6-Kbps throughput. The modem-to-computer interface rate is 115.2 Kbps, and some models have a proprietary protocol for high-speed cellular data transmission. Enhancements include 14.4-Kbps fax capabilities, support for EIA Class 2.0 fax communication, dial-back and link security, and the V.25bis protocol for synchronous dialing.

Phone: (708) 982-5010.

Circle 1069 on Inquiry Card.





PENTIUM TOWER

The TP66E2/VL tower workstation (from $4999) has two in-line 60-MHz Pentium processors. Each built-to-order system includes 512 KB of processor cache, a dual-channel SCSI-2 connection, an S3 video accelerator with 1 MB of DRAM, 4 MB of system RAM (expandable to 128 MB), 12 drive bays, and eight expansion slots. The EISA-bus system supports symmetrical multiprocessing under Windows NT and SCO Unix. The basic system ships without a monitor or hard drive.

Contact: Ambra Computer, Raleigh, NC, (919) 713-1550.

Circle 1060 on Inquiry Card.

Hardware

PERSONAL DEVICE PROGRAMMER

The ChipLab Project Programmer (from $895) from Data I/O (Redmond, WA) provides universal device support, such as flash, PROM, EPROM, PALs, microcontrollers, and sequencers.



Built for design engineers, ChipLab provides immediate support for target devices. The unit also provides configuration flexibility that lets you use it in other projects. ChipLab uses the company's standard device-programming algorithms, supports more than 40 device manufacturers and up to 48-pin packages, and accepts industry-standard ABEL files or JEDEC output.

Phone: (800) 332-8246 or (206) 881-6444.

Circle 1131 on Inquiry Card.

UPGRADE TO VESA LOCAL BUS

A kit for converting your ISA 386DX, 486SX, or 486DX PC to a VL-Bus system is available from PC-Build Computer Kits (Needham, MA). The conversion package ($450, installed) includes an upgradable VL-Bus motherboard, 128 KB of expandable cache memory, a VL-Bus IDE controller, and an expandable 1-MB VL-Bus Super VGA video board with software drivers.

Phone: (617) 449-7575.

Circle 1132 on Inquiry Card.

DETACHABLE DISPLAY

The detachable display becomes a projection panel on Krolman's (Toronto, Ontario, Canada) pc-Panel ($7950), an active-matrix color LCD projection panel and 33-MHz 486 notebook in one. You can add full-motion video clips to your presentations while working in PowerPoint, WordPerfect Presentations, or Harvard Graphics. The 7-pound system ships with 8 MB of RAM, a 200-MB removable hard drive, a 3½-inch floppy drive, I/O ports, and a built-in trackball.

Phone: (800) 388-3639 or (416) 931-7039.

Circle 1133 on Inquiry Card.

SCSI FOR THE LOCAL BUS

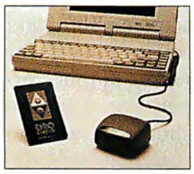
From American Megatrends (Norcross, GA), the Fast Disk VLB SCSI host adapter ($550) for motherboards using the VESA local bus supports up to 8 GB and seven SCSI drives. Throughput is 10 MBps; an on-board 16-MHz 386SX processor directs the I/O and cache support for up to 16 MB of on-board RAM.

Phone: (800) 828-9264 or (404) 263-8181.

Circle 1135 on Inquiry Card.

PRESENTATION CONTROL

The two-button, credit-card-size ProPresenter ($99) from Presentation Electronics (Rocklin, CA) gives you remote control over



your presentations. In versions compatible with PCs or Macs, the device provides forward and reverse capabilities and requires no software installation for use with most presentation programs (software is provided for customizing ProPresenter). The device attaches to the PC mouse port or the Mac ADB and is upgradable to the ProPresenter Plus (upgrade, $80).

Phone: (916) 652-9281.

Circle 1134 on Inquiry Card.

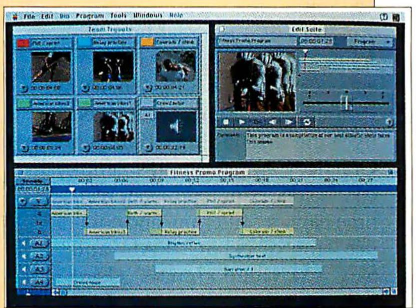
FASTER LABEL PRINTING

The LabelWriter II ($249.95) from CoStar (Greenwich, CT) plugs into the serial port of your Mac and adds a text-only mode for quick printing. Other enhancements include the CoStar Driver, an INIT file that provides background printing; consolidation of the three windows into one resizable window; expanded functionality in the Desk Accessory; and addition of Printer and Printer Setup menus.

Phone: (800) 426-7827 or (203) 661-9700.

Circle 1137 on Inquiry Card.

DIGITAL VIDEO SYSTEM



Media 100 ($11,995), a digital, on-line, nonlinear video-production system, lets you create NTSC or PAL video programs directly from your Mac. After you digitize your analog video and audio and store it, you can edit a complete video program using a picture-based interface and then record the finished program back onto videotape. Media 100's video output is 60 fields and 30 frames per second. The system, which consists of two NuBus boards and video-production software, supports input and output of four independent tracks of CD-quality stereo audio.

Contact: Data Translation, Marlborough, MA, (508) 460-1600.

Circle 1061 on Inquiry Card.

A NOTEBOOK FOR GRAPHICS

With a 9½-inch active-matrix color screen, the 486DX2-66 Smartbook ($4631) is designed for CAD and graphic artists. When the unit is connected to an external monitor, you can increase the resolution to 1024 by 768 pixels. From Commax Technologies (San Jose, CA), the 6.2-pound notebook has a built-in trackball and a front-loading 3½-inch floppy drive.

Phone: (408) 435-5000.

Circle 1138 on Inquiry Card.

HEAVY-DUTY BUT QUIET

The Genicom (Chantilly, VA) Model 3940IP heavy-duty dot-matrix printer ($3995) has two co-resident paper paths. You can load two different forms or identical forms, and the printer will automatically switch to the second box of paper when the first runs out. Features in the 55-dB, 600-cps printer include a font-selection command, an automatic head-gap feature that senses the thickness of forms and automatically adjusts for optimum print quality, and head-gap memory that lets you program the printer to recall the format for specific forms.

Phone: (800) 443-6426 or (703) 802-9200.

Circle 1273 on Inquiry Card.

CD MAKER

You can create ISO9660–compliant CDs with the RCD-202 PC ($4195), a recordable CD mastering system with a premastering feature for Windows, from Pinnacle Micro (Irvine, CA). The discs (blank, $39 each) can be read on a standard CD-ROM drive on any platform. You can create audio, audio and CD-ROM, CD-XA, CD-I, and multisession discs (Kodak Photo CD and Pinnacle Micro standards), which enable you to write and read data in more than one recording session. You can also use the RCD-202 PC as a backup device.

Phone: (800) 553-7070 or (714) 727-3300.

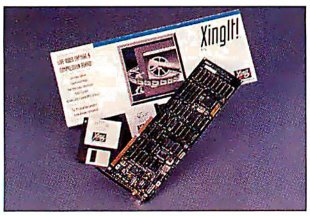
Circle 1136 on Inquiry Card.



What's New Hardware

CAPTURE AND COMPRESS IMAGES

XingIt ($795) is a real-time 30-frame-per-second MPEG video-encoder board for 386, 486, and Pentium PCs. Jointly developed by Xing Technology (Arroyo Grande, CA) and Philips Semiconductors, XingIt provides real-time capture, filtering, and compression of NTSC, PAL, and SECAM video signals. Used with Microsoft Video for Windows, it also provides MPEG



software playback in a 320- by 240-pixel window synchronized with WAV or MPEG audio without special display hardware.

Phone: (800) 294-6448 or (805) 473-0145.

Circle 1271 on Inquiry Card.

EASY SCANNING

An entry-level scanner, the ActionScanning System ($999) from Epson America (Torrance, CA) is built around the company's ES-600C, a single-pass, 24-bit color scanner. It comes with Photoshop 2.5 LE image-editing software, a Scantastic PS plug-in module, and a SCSI cable.

Phone: (800) 289-3776 or (310) 782-0770.

Circle 1143 on Inquiry Card.

CAD PLOTTER

From Pacific Data Products (San Diego, CA), the ProTracer II personal CAD plotter ($1599) is specifically designed for working in AutoCAD. The plotter produces *C*-size plots at 360-dpi resolution or office documents on standard office paper and provides resident Epson LQ-1050 and IBM ProPrinter XL24E emulation. The plotter is also upgradable.

Phone: (619) 552-0880.

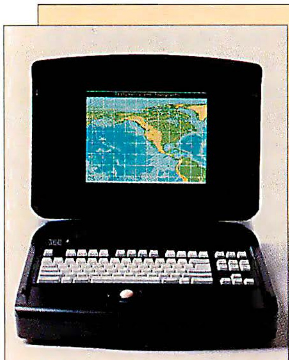
Circle 1279 on Inquiry Card.

MAGNETO-OPTICAL DRIVE

LaserSafe Plus ($4995), a read/write removable magneto-optical drive for Macs and PCs, holds ISO-standard 1.3-GB disks and is backward compatible with 1-GB and 650-MB disks. From Iomega (Roy, UT), the drive has a sustained read capability of 2.2 MBps, a sustained write capability of 1.1 MBps, and an average seek time of 19 ms, the company says. Its read/write cache is 4 MB.

Phone: (801) 778-1000.

Circle 1276 on Inquiry Card.



PORTABLE UNIX

Based on the IBM RS/6000 Powerstation 220 workstation, the Powerportable (from $13,495) offers Model 220 functionality, letting you download software from any RS/6000 machine, work with it, and then upload it. The Powerportable runs AIX 3.2 for the RS/6000 and includes 8 KB of I/O cache, a 32-bit Micro Channel adapter slot, and system I/O control logic. Other features include an active-matrix color LCD, a 457-MB or 1.2-GB removable hard drive, 16 MB of RAM, and Ethernet and SCSI connectors.

Contact: Acer America, San Jose, CA, (800) 366-3355 or (408) 432-6200.

Circle 1062 on Inquiry Card.



SIMULTANEOUS SOUNDS

From Orchid Technology (Fremont, CA), the SoundWave 32 advanced wavetable/DSP sound card ($299) provides simultaneous multimedia compatibility and support for the leading sound standards, letting you switch among standards, access multiple standards simultaneously, and update to new ones without additional hardware. The 16-bit card has more than 8 MB of sound samples; built-in CD-ROM interfaces for Sony and Mitsumi drives; and interfaces for stereo speaker output, microphone input, line output to connect to a home stereo, and line input for external audio devices. Speakers and a microphone are included.

Phone: (510) 683-0300.

Circle 1145 on Inquiry Card.

RISC BOX RUNS WINDOWS NT

A Mips R4400–based RISC PC for Windows NT, the limited-edition rPC 44LE ($4495) from DeskStation Technology (Lenexa, KS) joins the company's Evolution Series of computers. The minitower is built around a 50-MHz processor that operates internally at 100 MHz. The rPC 44LE includes 16 MB of RAM (expandable to 64 MB), 512 KB of secondary cache memory, a SCSI-2 subsystem with a 240-MB hard drive and a Sony CD-ROM drive, an S3-based video card, and Windows NT installed.

Phone: (800) 793-3375 or (913) 599-1900.

Circle 1275 on Inquiry Card.

ANALOG FILM RECORDER ▲

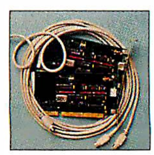
Datagraf's (Wheeling, IL) Screen Image Recorder produces high-quality photographic images from your computer or workstation screen without software drivers. The SIR-115 ($6000), for the Mac, and the SIR-121 ($6500), for coexisting PCs and Unix workstations, are fully compatible with all software programs, according to Datagraf. The passive hardware interface completes a 35mm image in less than 15 seconds. You can also attach the image recorder to any computer-based microscope system for direct imaging of the system's monitor.

Phone: (800) 538-9231 or (708) 520-1223.

Circle 1140 on Inquiry Card.

A LAN FOR ONE

Designed for those who work with more than one PC, One-Man-LAN (from $199) from PC InterConnect (Provo, UT) lets you access files on one or more secondary PCs as if the files



were located within your primary system. You can convert any of your machines into a secondary or server PC and then return it to primary status. The two half-height ISA cards and software are compatible with Windows, NetWare, LANtastic, and Windows for Workgroups, as well as sector-level disk utilities and CD-ROMs. One-Man-LAN supports data transfer rates of up to 680 KBps.

Phone: (801) 374-8880.

Circle 1066 on Inquiry Card.

Hardware

LONG DISTANCE FOR A SHORT-RANGE MODEM ▼

A short-range modem that can operate at distances of up to 14 miles over unshielded twisted-pair cable, the Model 1226 ($165) can communicate with a serial device or another parallel



device. From Patton Electronics (Gaithersburg, MD), the modem sends data at a rate of 57.6 Kbps. With optical isolation and surge protection, the bidirectional Model 1226 can withstand ground loops and transient surges.

Phone: (301) 975-1000.

Circle 1274 on Inquiry Card.

MULTIMEDIA MONITOR

A 15-inch color monitor with built-in stereo speakers, the FM-1561A ($799) accepts VGA, Super VGA, and noninterlaced video-input signals at a maximum resolution of 1280 by 1024 pixels. From Proton (Cerritos, CA), the monitor has a flat, antistatic, low-emission screen with an adjustable antiglare visor and a removable glass VDT filter.

Phone: (310) 404-2222.

Circle 1277 on Inquiry Card.

PRINTING IN KANJI

The Kanji JetWriter SX-600 ($4995) is compatible with PCs, Macs, and Unix-based computers. The 600-dpi, 8-ppm printer includes expandable mincho and gothic kanji fonts and 35 standard English PostScript fonts. RISC-based, the printer has 8 MB of RAM (expandable to 16 MB), a 40-MB SCSI hard disk, dual page processing, HP PCL compatibility, and advanced memory management. The I/O Software (Rancho Cucamonga, CA) printer can print at 101 levels of gray scales.

Phone: (909) 483-5706.

Circle 1278 on Inquiry Card.

CELLULAR LINK FOR MODEMS AND FAXES



The I.D.E.A. (Intelligent Data Equipment Adapter) lets you connect your modem or fax machine to a portable cellular phone. Powered by a standard 9-V battery, the I.D.E.A. (from $249.95) gives your cellular phone the characteristics of a standard phone line. The microprocessor-controlled system generates a dial tone, controls the functions of the phone, and provides a standard RJ-11 interface. The system, which is compatible with PCs, Macs, and palmtops, does not require additional software.

Contact: Ora Electronics, Chatsworth, CA, (818) 772-2700.

Circle 1063 on Inquiry Card.

MULTIDEVICE DIGITIZER TABLET

The Mac-compatible 12- by 12-inch UD-1212 multidevice digitizer tablet ($695) tracks a stylus and a four-button cursor simultaneously. You can grab objects on the screen with both pointers



and manipulate them faster and more naturally than previously possible. The Wacom Technology (Vancouver, WA) device has a customizing menu strip with two pressure buttons that let you set the pressure-sensitive UltraPen for a firm or soft touch. Twelve function/macro buttons and configure-setup/save and mode-selection buttons are also on the strip. The UltraPen offers 120 pressure levels and has a side switch that you set for specific functions.

Phone: (800) 922-6613 or (206) 750-8882.

Circle 1139 on Inquiry Card.

TURN YOUR PC GREEN

It looks like a power strip, but the PC Ener-g Saver ($69.95) can sense when your PC is no longer in use and automatically switches it into a power-saving standby mode. You connect your CPU, monitor, keyboard, and printer to the device from PC Green Technologies (La Palma, CA), which works in concert with TSR software under DOS and as a WIN.INI file in Windows. The software also audits energy costs, letting you calculate savings and the payback period. An on-screen configuration panel allows you to independently control monitor and printer power.

Phone: (800) 984-7336 or (714) 228-2230.

Circle 1144 on Inquiry Card.

TWO GRAPHICS CARDS FOR THE VL-BUS

ATI Technologies' (Toronto, Ontario, Canada) first retail VESA Local Bus card uses the company's mach32 graphics controller. The Graphics Ultra Pro VLB ($499) has 2 MB of VRAM and displays at resolutions of up to 1280 by 1024 pixels at 74 Hz. At 800- by 600-pixel resolution, the card displays 24-bit color.

Phone: (416) 882-2600.

Circle 1141 on Inquiry Card.

Cardinal Technologies' (Lancaster, PA) VideoSpectrumVL ($199) uses a Cirrus 5428 accelerator chip and has 1 MB of DRAM. The card displays at resolutions of up to 1280 by 1024 pixels in 16 colors. At 640- by 480-pixel resolution, the card displays 24-bit color.

Phone: (717) 293-3000.

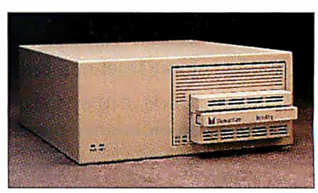
Circle 1142 on Inquiry Card.

2 GB TO GO

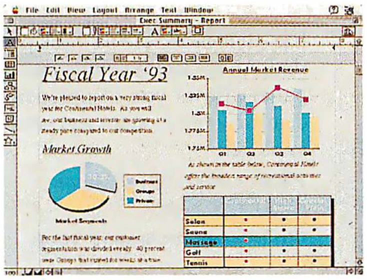
The Mac-compatible IncreMeg removable hard drive cartridge ($4586) now has a capacity of 2 GB. From MountainGate Data Systems (Reno, NV), the 3½-inch full-height cartridge can be used by itself or with the IncreMeg 6000, for a capacity of up to 12 GB. The cartridge has patented shock protection, spin-up/spin-down electronics, drive-status indicators, and a SCSI-2 connector.

Phone: (800) 556-0222 or (714) 998-6900.

Circle 1272 on Inquiry Card.



What's New Software



CREATE, INTEGRATE, COMMUNICATE ▲

Claris (Santa Clara, CA) calls it business-graphics-processing software. ClarisImpact 1.0 for Macintosh ($399) puts in a single application the means of creating, editing, and presenting integrated text and graphics in reports or slides. Features encompass automatic graphics models for organizational charts and flowcharts, time lines, and network diagrams; "intelligent" editing; integrated word processing and presentations; and seamless cross-platform capabilities.

Phone: (408) 987-7000.

Circle 1285 on Inquiry Card.

WINDOWS CLIENT FOR OPTIX

Optix PC View ($995 per user) from Blueridge Technologies (Flint Hill, VA) allows PCs running Windows to view document-image and text databases on multiuser Optix networks. With Optix PC View, users of Windows-based PCs can query, retrieve, view, and print images from the Unix-based SQL Optix Network Server and Natural Language Search text-search engine. The Optix client software lets Windows PCs call up files that take on the same screen appearance as they would on Mac clients.

Phone: (703) 675-3015.

Circle 1286 on Inquiry Card.

READ THE NEWS ON YOUR MAC

MacWire ($995) lets you use your Mac to receive, filter, and display news in real time. From Mainstream Data (Salt Lake City, UT), MacWire works in background mode and thus does not need a dedicated computer. The software is fully compatible with wire services such as AP, Knight-Ridder/Tribune, UPI, Reuters, Business Wire, and Agence France Presse. It can also receive FM and satellite transmissions.

Phone: (801) 584-2800.

Circle 1284 on Inquiry Card.

CREATE 3-D AND MOTION SEQUENCES

Visual Reality ($595) from Visual Software (Woodland Hills, CA) lets you create photo-realistic 3-D images and motion sequences in Windows. Built around the company's Renderize for Windows, Visual Reality has three other modules. The 3-D modeling module includes functions such as splines, cut, extrusion, and surface of revolution as well as basic building blocks of spheres, polygons, and cubes. The Renderize Live camera-animation module produces walk-throughs and fly-bys, and the image-composition module lets you create and manipulate multiple layers and work on high-resolution images in 2-D.

Phone: (818) 883-7900.

Circle 1287 on Inquiry Card.

SIMPLY COMMUNICATE

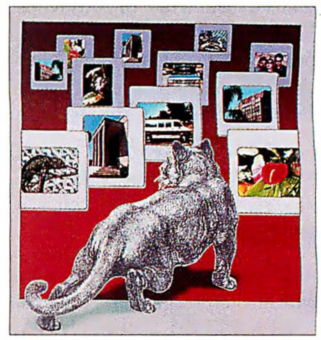
SITcomm (Simply Intuitive Telecommunications, $120) is a communications program that lets Mac users connect to commercial on-line services, BBSes, and the Internet. With a toolbar user interface, the Aladdin Systems (Watsonville, CA) software provides quick access to its main features. You can set up SITcomm so that it automatically logs on to communications services through an address book that contains your settings for each service you use. The program has automatic expansion and compression, foreign-file translation, and scripting.

Phone: (408) 761-6200.

Circle 1288 on Inquiry Card.

IMAGE MANAGER

Xing Technology's (Arroyo Grande, CA) Picture Prowler image management software utility ($49.95) compresses imported images in real time. The software imports BMP, TIF, TGA, GIF, PCX, WMF, and WPG files and converts them to ISO-standard JPEG format. Interactive thumbnail scrolling lets you quickly make a visual search of the cataloged images, retrieve them, and decompress them for viewing.



Phone: (805) 473-0145.

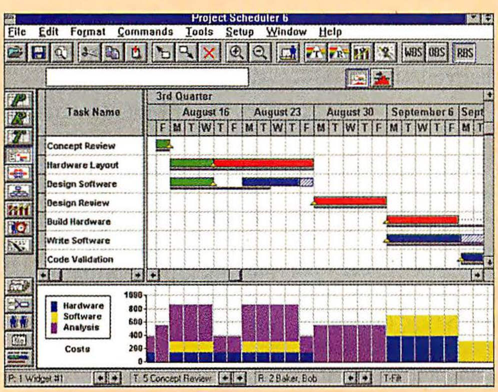
Circle 1289 on Inquiry Card.

32-BIT PC X SERVER

With Exceed/NT ($645) from Hummingbird Communications (Markham, Ontario, Canada), you can work in Windows NT to connect to and display applications from X Window System–based systems. The seamless integration allows you to concurrently execute X clients and DOS, Windows, and Windows NT applications. Two windowing modes are available, and you can switch modes on the fly.

Phone: (416) 470-1203.

Circle 1290 on Inquiry Card.



A MANY-FACETED SCHEDULER

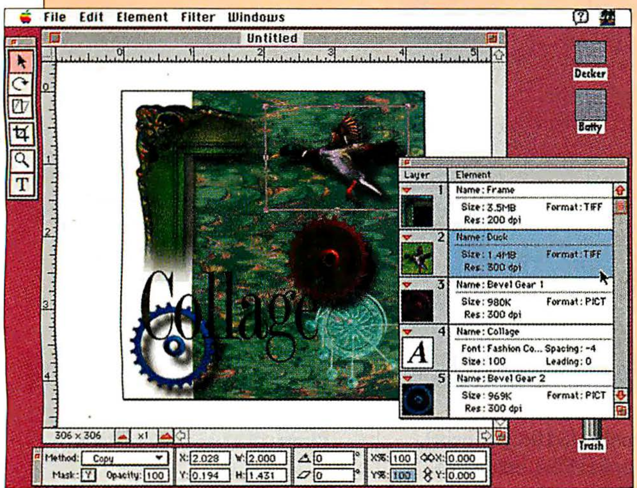
Project Scheduler 6 for Windows ($695) provides easy-to-use tools for planning, tracking, analysis, and reporting for multiple projects. Incorporating the ARTS (Advanced Resource Tracking Spreadsheet) technology, Project Scheduler lets you compare your baseline estimates of cost, work force, and time with the actual data you've entered to date and the remaining work to be done on an hourly, daily, weekly, or monthly basis.

The software supports matrix management with work, organizational, and resource breakdown structures that you can sort, filter, and cross-reference. Analysis and scenario modeling capabilities have an unlimited undo/redo option, and ODBC support lets you create a centralized project repository on the server. With the Object Oriented Report Writer, you can create custom reports of project data, such as time distribution and selective summaries, at any level of a breakdown structure.

Contact: Scitor, Foster City, CA, (415) 570-7700.

Circle 1280 on Inquiry Card.

Mac Image Builder



The object-oriented, high-resolution image-composition program Specular Collage ($395) works with graphics packages such as Adobe Photoshop and QuarkXPress to speed up and add flexibility to creating complex imagery. Collage defines each image element as an object that's separate from other image elements, letting you make corrections or adjustments to individual elements without having to re-create the entire composition. Features include import and export of PICT and TIFF files, a desktop page-layout interface, live alpha channels, numerical input, feathering, automatic shadows, and manipulation of high-resolution images as proxies.

Contact: Specular International, Amherst, MA, (413) 253-3100.

Circle 1281 on Inquiry Card.

PUT THE WORLD AT YOUR FINGERTIPS ▼

The comprehensive Broderbund (Novato, CA) PC Globe Maps 'n' Facts (about $30) is a world atlas and almanac that combines detailed geographical, political, and statistical information. The object-oriented program lets you print maps in black and white or color; export maps, charts, and text to reports; check the real-time world time-zone map; zoom in from the world to a region; calculate the distance from one point to another; and convert the value of one country's currency to that of another. For IBM-compatible PCs.

Phone: (415) 382-4400.

Circle 1292 on Inquiry Card.



ELECTRONIC MERCK MANUAL

The Merck Manual Text-Stack (from $220) puts *The Merck Manual*, the world's most widely used medical reference, on Macintoshes and PCs with Windows. The software from Keyboard Publishing (Blue Bell, PA) features the complete text of the sixteenth edition, including its more than 600 figures, tables, and diagrams. Search functions let you immediately access information and provide options for manipulating the data.

The Mac Clippings and Windows Copy-and-Paste features allow you to mark sections of text and copy them to a word processing program. Transcriber lets you highlight text sections and assemble them into a transcript that you can play back or edit.

Phone: (800) 945-4551 or (215) 832-0945.

Circle 1291 on Inquiry Card.

NETWORK PRINTING FOR WORKSTATIONS

Seiko Instruments USA (San Jose, CA) has released a network-printing software application for Unix and VMS workstations. CHCopy (from $999) runs on Motif and Open Look windows systems. It provides a consistent way to capture, preview, and correct screen images and graphics files and then print them to any of the company's color printers.

Phone: (408) 922-5800.

Circle 1301 on Inquiry Card.

REPORT WRITER/QUERY TOOL FOR UNIX

IQ Software's (Norcross, GA) Unix GUI version of Intelligent Query, IQ for Motif ($750 per workstation) combines the functionality of Intelligent Query with special features of Motif, such as batch processing, resizable dialog boxes, and hypertext help. Initially available on Data General's Aviion, DEC's Ultrix, Hewlett-Packard's workstations, IBM's RS/6000, SCO's Open Desktop, and Sun's workstations, IQ for Motif supports access to relational databases such as Informix, Oracle, Sybase, and Rdb as well as 3GL file systems such as COBOL and BASIC.

Phone: (404) 446-8880.

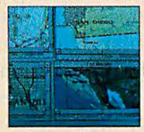
Circle 1295 on Inquiry Card.

Software Update

Network Archivist 3.0, Palindrome (Naperville, IL), adds optical, DLT, and expanded robotic support, a configurable server-migration threshold, a choice of automated tape-rotation models, and enhanced rotation configuration. $1695.

Phone: (708) 505-3300.

Circle 1305 on Inquiry Card.



SureMaps 2.0, Horizons Technology (San Diego, CA), adds Windows and multiple map capability, a library of 22 optional map sets, the capability to import spreadsheet and database files containing latitude/longitude coordinates or street addresses, and the ability to draw lines, rectangles, circles, and polygons to annotate map areas. $199; optional map sets, $99.

Phone: (619) 292-8331.

Circle 1307 on Inquiry Card.

DeskTracy 2.0, KansasBay Systems (Oakland, CA), adds control access, a charge meter, Ethernet and multiple-zone tracking, and an administration module. $149.

Phone: (510) 339-7300.

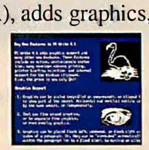
Circle 1309 on Inquiry Card.

Here & There 1.1, Fifth Generation Systems (Baton Rouge, LA), adds Windows functionality and an international phone book. $149.

Phone: (504) 291-7221.

Circle 1315 on Inquiry Card.

PC-Write 4.1, Quicksoft (Seattle, WA), adds graphics, envelope printing, a customizable status line, a stress indicator, Windows Clipboard support, and more. $69.



Phone: (206) 282-0452.

Circle 1306 on Inquiry Card.

What's New Software

CREATE CIRCUIT DESIGNS

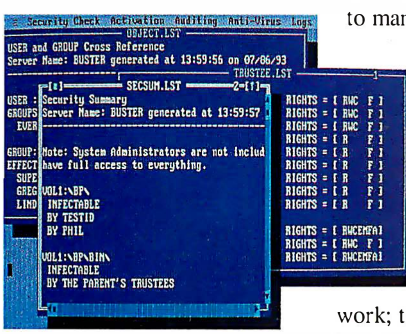
A schematic capture and digital-simulation program from MicroCode Engineering (Orem, UT), CircuitMaker ($199) lets you easily draw, modify, and combine circuit diagrams by employing your mouse to select devices from the device library. Advanced editing capabilities include rubber-band moving of wires and devices; cut, copy, and paste; and 90-degree rotation. The simulation feature allows you to test a circuit before you build it, and the trace option lets you simultaneously view the states of all nodes as the simulation runs. The macro devices feature lets you create your own functional devices, and you can export and print the circuit and waveforms.

Phone: (801) 226-4470.

Circle 1304 on Inquiry Card.

NETWORK SECURITY ▼

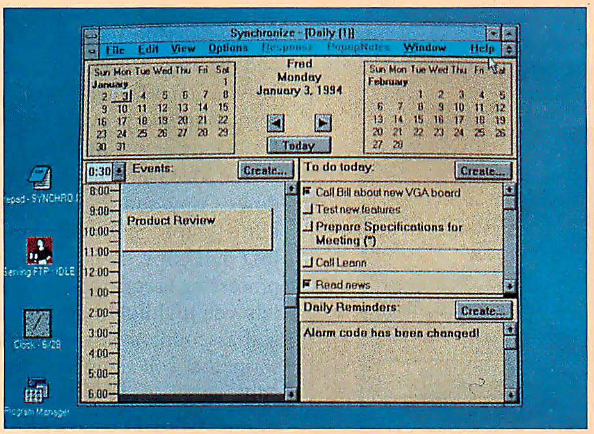
The Network Security Organizer ($250 for a five-user license) from Leprechaun Software (Marietta, GA) is a network management tool that gives system administrators centralized control over workstation-based security and any antivirus system that is installed. Additionally, the program analyzes network vulnerability to viruses and provides centralized asset management for workstation hardware and software as well as centralized reporting of virus hits across the network.



Phone: (404) 971-8900.

Circle 1296 on Inquiry Card.

ENTERPRISE-WIDE SCHEDULING IN WINDOWS



The Windows client release of Synchronize ($100 per user), a scheduling and task management application, communicates directly across TCP/IP for worldwide access. The client/server design supports multiple time zones, letting you assign databases across geographic divisions of your enterprise-wide network. You can schedule meetings and resources, distribute agendas and memos, assign and track tasks, and send out reminders. You have access to daily, weekly, and monthly private and group calendar views, pop-up notes, and automatically updated to-do lists. The software supports PostScript printing and can run on palmtops.

Contact: CrossWind Technologies, Felton, CA, (408) 335-4988.

Circle 1282 on Inquiry Card.

The Novell Interface Module (from $49.95), PC Guardian's (San Rafael, CA) newest Data Security Plus module, allows a NetWare system administrator to manage from a remote location all access-control functions for a network and for workstations on the network. The module continually synchronizes your name and password on the workstation with your name and password on the network; thus, after gaining access to your workstation, you can log in to the network at any time without having to reenter your name and password.

Phone: (800) 288-8126 or (415) 459-0190.

Circle 1297 on Inquiry Card.

TWO-WAY CONNECTION

ReachOut Total Remote ($249) from Ocean Isle Software (Vero Beach, FL) provides remote control and remote access across dissimilar networks. You can use the control and access capabilities at the same time or separately and dynamically switch between them. Features include the capability to prepare a document on a laptop, dial into the office network, and then fax the document using the office fax software. You can use the Total Remote file manager to transfer files between two PCs, synchronize files on both machines, or use the DOS copy command, the DOS shell, the Windows File Manager, or other file manager.

Phone: (407) 770-4777.

Circle 1294 on Inquiry Card.

Software Update

Paragon 4.0, BusLogic (Santa Clara, CA), adds enhanced drive reconstruction performance, remote diagnostics, and nonstop server access. $995.

Phone: (408) 492-9090.

Circle 1311 on Inquiry Card.

The Far Side Daily Planner and Calendar Publisher 3.0, Delrina (San Jose, CA), adds an address book, searching, sorting, file importing and exporting, printing, and integration with Delrina WinFax Pro. $59.95.

Phone: (408) 363-2345.

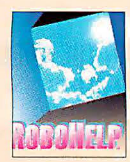
Circle 1312 on Inquiry Card.

Protab 5.0, DMC Design (San Jose, CA), adds a parametric fastener library, automatic border insertion and scaling, automatic associative ordinate dimensioning, improved orthographic-to-isometric conversion, batch plotting, and AutoCAD integration with XTreeGold. $299.

Phone: (408) 238-9190.

Circle 1310 on Inquiry Card.

RoboHelp 2.0, Blue Sky Software (La Jolla, CA), adds the ability to use a single text source for the help system and printed documentation, an error wizard, enhanced hypertext linking, new graphics capabilities, the ability to import existing help-project source files, and simulation mode. $495.



Phone: (619) 459-6365.

Circle 1308 on Inquiry Card.

By Design for WordPerfect 6.0, Streetwise Software (Santa Monica, CA), adds a multifunction address book; the Smart Docs Design System; improved and new design tools, fonts, and clip art; and Quick Doc. $99.

Phone: (310) 829-7827.

Circle 1313 on Inquiry Card.

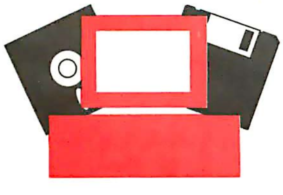
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Address ____________________

City ____________ State ______ Zip ______

Phone ____________ Fax ____________

A. What is your primary job function/principal area of responsibility? (Check one)
1 ☐ MIS/DP
2 ☐ Programmer/Systems Analyst
3 ☐ Adminstration/Management
4 ☐ Sales/Marketing
5 ■ Engineer/Scientist
6 ■ Other

B. What is your level of management responsibility?
7 ☐ Senior-level
8 ☐ Middle-level
9 ☐ Professional

C. Are you a reseller (VAR, VAD, Dealer, Consultant)?
10 ☐ Yes
11 ■ No

D. What operating systems are you currently using? (Check all that apply)
12 ☐ PC/MS-DOS
13 ■ DOS + Windows
14 ■ OS/2
15 ■ Unix
16 ☐ MacOS
17 ☐ VAX/VMS

E. For how many people do you influence the purchase of hardware or software?
18 ☐ 1-25
19 ☐ 26-50
20 ☐ 51-99
21 ☐ 100 or more

November 1993 | 91 96 98 |

Card Valid until January 31, 1994

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647	648	649	650	651	652	653	654	655	656	657	658	659	660	661	662	663
664	665	666	667	668	669	670	671	672	673	674	675	676	677	678	679	680
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Inquiry Numbers 800–986

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970	971	972	973	974	975	976	977	978	979	980	981	982	983	984	985	986

Inquiry Numbers 987–1151

987	988	989	990	991	992	993	994	995	996	997	998	999	1000	1001
1002	1003	1004	1005	1006	1007	1008	1009	1010	1011	1012	1013	1014	1015	1016
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1137	1138	1139	1140	1141	1142	1143	1144	1145	1146	1147	1148	1149	1150	1151

Inquiry Numbers 1152–1316

1152	1153	1154	1155	1156	1157	1158	1159	1160	1161	1162	1163	1164	1165	1166
1167	1168	1169	1170	1171	1172	1173	1174	1175	1176	1177	1178	1179	1180	1181
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Inquiry Numbers 1317–1481

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1467	1468	1469	1470	1471	1472	1473	1474	1475	1476	1477	1478	1479	1480	1481

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Hardware

Category	No.
Accessories/Supplies	1
Add-in Boards	2
Bar Coding	3
Communications/Networking	4
Computer Systems	5
Data Acquisition	6
Disks & Optical Drives	7
Diskettes/Duplicators	8
Fax Boards/Machines	9
Graphics Tablets/Mice/ Pen Input	10
Keyboards	11
LAN Hardware	12
Laptops & Notebooks	13
Mail Order	14
Memory/Chips/Upgrades	15
Miscellaneous Hardware	16
Modems/Multiplexors	17
Monitors & Terminals	18
Multimedia	19
Printers/Plotters	20
Programmable Hardware	21
Scanners/OCR/Digitizers	22
Tape Drives	23
UPS	24

Software

Category	No.
Business	25
CAD/CAM	26
Communications/Networking	27
Data Acquisition	28
Database	29
Educational	30
Engineering/Scientific	31
Entertainment	32
Graphics	33
Macintosh	34
Mail Order	35
Mathematical/Statistical	36
Miscellaneous Software	37
On-Line Services	38
Operating Systems	39
Programming Languages/ Tools	40
Security	41
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Utilities	46
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Category	No.
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Recruitment	50
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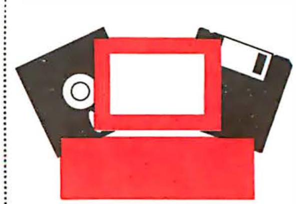
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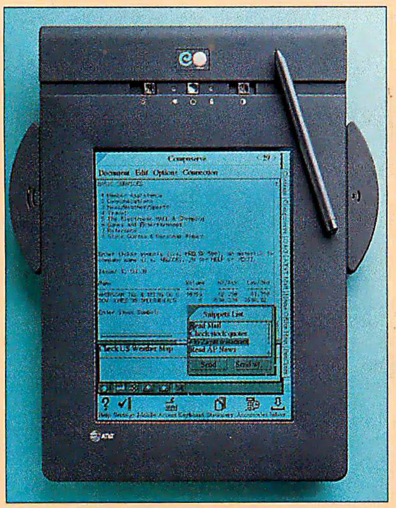
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What's New Software

A Link for Pen-Based Systems



Communications software for pen computers, Mobile Access–Personal ($195) lets pen-based devices that use AT&T Hobbit or Intel 80x86 processors access on-line information and send and receive documents over cellular, two-way radio, and land-based phone lines. Connectivity is via such transfer protocols as Text/ASCII, XMODEM, YMODEM, and ZMODEM, and Kermit. You can capture and reuse text to create commands and use the snippets list for instant access to terminal commands you use frequently.

Contact: Notable Technologies, Foster City, CA, (510) 208-4400.

Circle 1283 on Inquiry Card.

AD HOC WORK-FLOW MANAGEMENT

Developed as an application for Knowledge Integration Center's (Dublin, OH) cross-platform work-flow manager KI Shell, Track-It ($400) can also be used as a stand-alone program. Track-It lets you plan, assign, and track daily ad hoc work on a project, giving you the capability to route forms and folders, access word processors and E-mail systems, and assign work to specified individuals or to a pool of individuals. You can also indicate the authorized level of effort expected of project members and specify reporting milestones.

Phone: (614) 792-9993.

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IMAGING FOR RESEARCH ▶

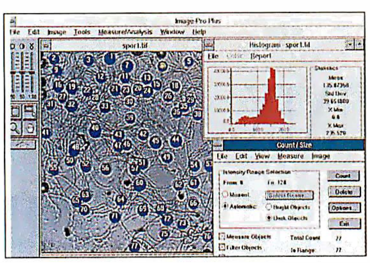


Image-processing software for scientific applications, Image-Pro Plus for Windows ($1999) is built on the multiplatform developer's toolkit HAIL (Halo Advanced Imaging Library). The Media Cybernetics (Silver Spring, MD) software allows you to capture and process images; make manual and automatic measurements and classifications; define areas of interest; extract individual color channels, process them, and merge them back into the original image; analyze histograms and line profiles; and perform JPEG compression. The software supports TWAIN scanners, is OLE 1–compliant, provides network access, and has a record/playback capability to automate repetitive tasks.

Phone: (301) 495-3305.

Circle 1293 on Inquiry Card.

OPEN DATABASE CONNECTIVITY LINK

An ODBC-compliant database utility for Windows, dbLink (from $199) from AT Software (Westlake Village, CA) lets you access and link data from any application that ODBC drivers have been developed for, such as dBase, Oracle, Paradox, SQL Server, SQL for NetWare, and SQLBase, to Windows applications that support DDE. Setup is automatic; dbLink operates independently of database format.

Phone: (805) 373-0051.

Circle 1302 on Inquiry Card.

E-MAIL LINK

Cyberdesk ($395) from CyberCorp (Kennesaw, GA) lets you connect to and manage multiple E-mail and public information systems. Compatible with CompuServe, MCI Mail, The Well, and cc:Mail, Cyberdesk's special agents log on to each system and retrieve public and private messages and on-line files. The program lets you set up a scheduling routine for it to follow while you work on other projects, and it lets you converse with colleagues who use different E-mail systems. A single address book applies to all systems.

Phone: (404) 424-6240.

Circle 1303 on Inquiry Card.

MULTIDIMENSIONAL ANALYSIS

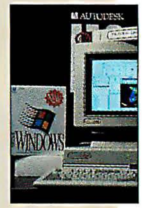
A spreadsheet that uses multidimensional analysis, Corporate Vision, The Super Spreadsheet ($690) provides direct access to your database and lets you build graphs and spreadsheets that automatically view relationships among all fields in a database. From IntelligenceWare (Los Angeles, CA), Corporate Vision supports hypergraphs, customizable dialog boxes, and hypertext. Windows-compatible Corporate Vision's open architecture lets you access data from databases such as dBase, Paradox, Oracle, Sybase, and SQL Server.

Phone: (310) 216-6177.

Circle 1299 on Inquiry Card.

Software Update

Drawing Librarian for Windows, SoftSource (Bellingham, WA), now can add AutoCAD drawings to any Windows program. $99.



Phone: (206) 676-0999.

Circle 1314 on Inquiry Card.

TapeWare LAN/386 4.2, Emeritus Technologies (Fresno, CA), adds a built-in tape-rotation manager with nine rotation schemes, NetWare 4.x Directory Service support, Btrieve 6.0 open-file-database support, capability to read ARCserve and ARCsolo tapes, and faster backup and restore speeds. From $299.

Phone: (209) 292-8888.

Circle 1316 on Inquiry Card.

WordPerfect 3.0 for Macintosh, WordPerfect Corp. (Orem, UT), adds feature compatibility with new versions of WordPerfect on other platforms and support for Apple's latest technologies, such as AOCE. It also integrates Grammatik 5. $495.

Phone: (801) 225-5000.

Circle 1317 on Inquiry Card.

PaperLess Filer 2.3, PaperLess Corp. (Richardson, TX), adds the ability to manage non-image data and applications software from within its application framework, new media management functions, and enhanced batch capabilities. The network version adds multilevel security. $495.

Phone: (214) 235-4008.

Circle 1319 on Inquiry Card.

BrainMaker 3.0 for Windows or DOS, California Scientific Software (Nevada City, CA), adds tighter control over training, integration with other software, and full integration with Windows. $195.

Phone: (916) 478-9040.

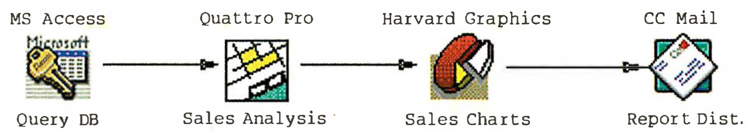
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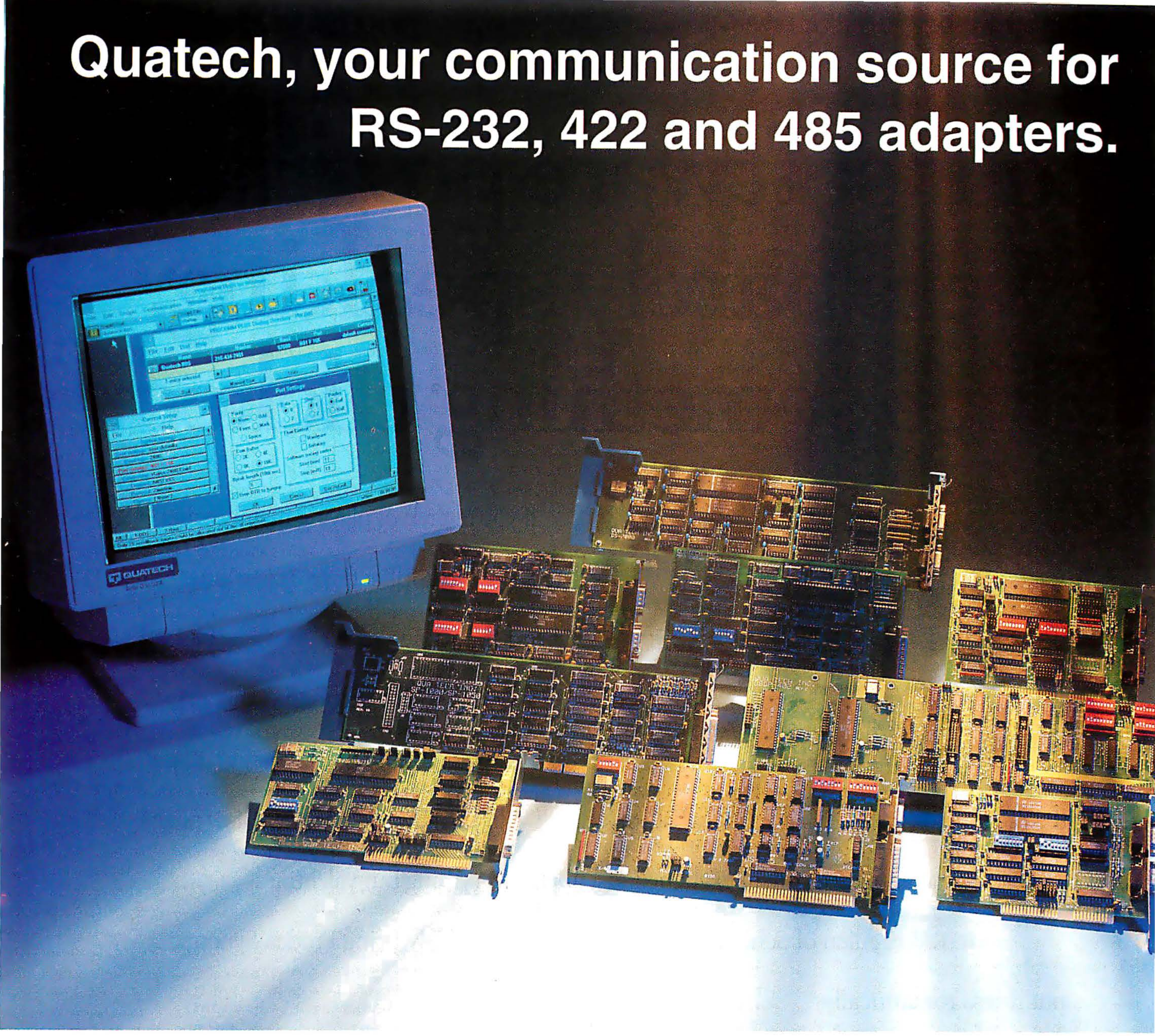
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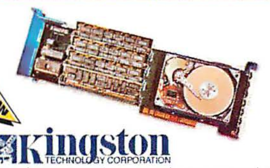
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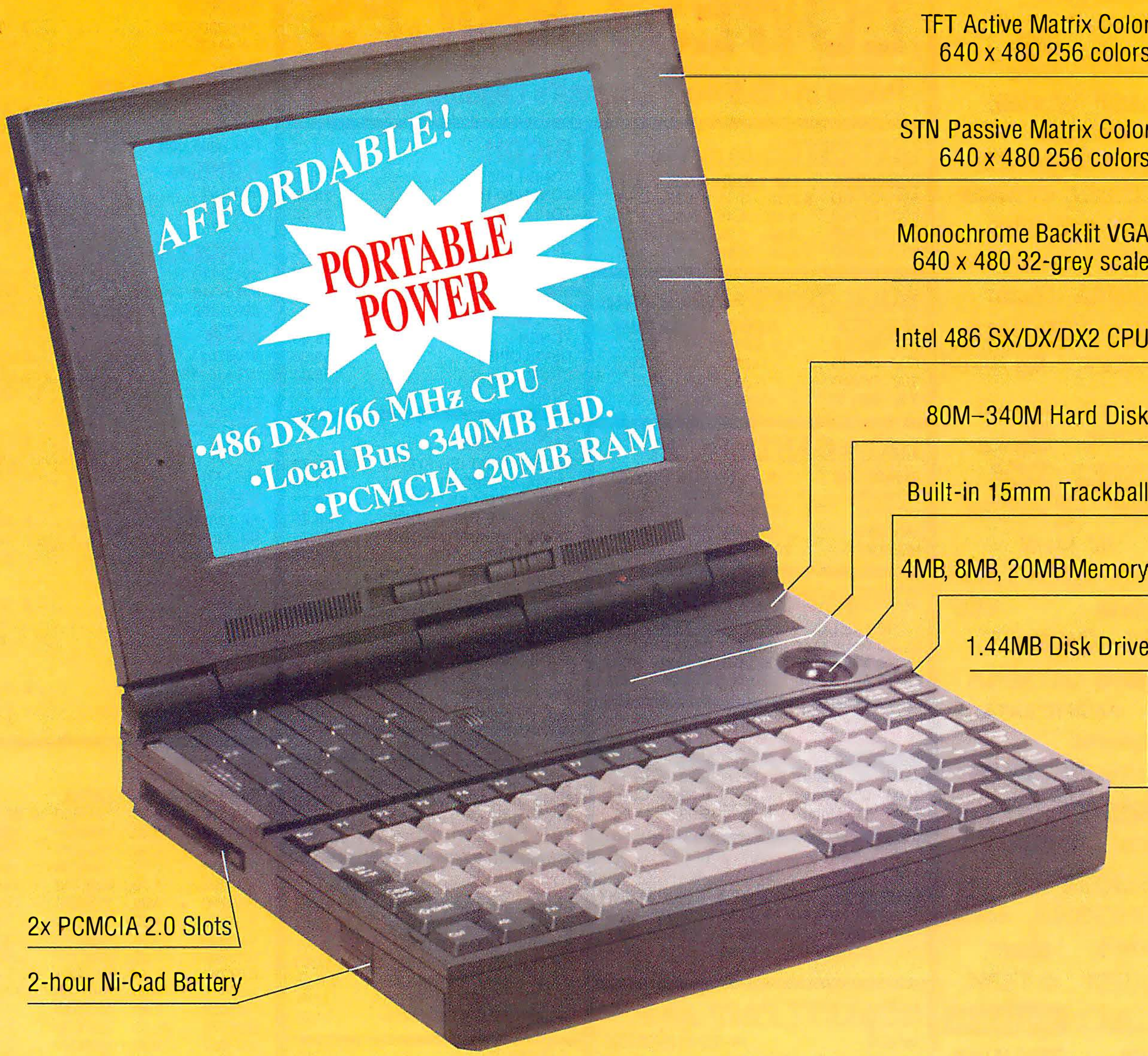
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	2-16MB	6450609	$368
2-8 MB FOR PS/2 50 & 60, 2MB $159, 4MB $259, 8MB $489			
PS/1 Consultant, Essentials & Expert models x43, x44 & PS/Valuepoint all models except Cxx series	4MB	N/A	$238
	16MB	N/A	$844
PS/2 70-A21; A61; B21; B61; PS/1 Consultant, Essential & Expert models x11, x13 & x14, PS/Valuepoint Cxx series	1MB	6450603	$49
	2MB	6450608	$99
PS/2 35SX; LS, 40SX, 55SX; LS, 65SX;	4MB	34F2933	$218
PS/2 90XP, 95 XP, P75 (Pairs), 5657 (all) 76, 77, PS/1 Pro 2123	2MB	6450902	$107
PS2 90, 95 XP, P75 (Pairs) 56, 57, (all) PS/1 Consultant, Essential, Expert x11, x13 & x14, PS/1 Pro 2123, RS/6	4MB	6450128	$218
	8MB	6450130	$468
PS2/2 35SX; LS; 40SX	8MB	6450129	$468
PS2 70's and 80's	2-8MB	6450605	$297
32 BIT BOARDS	2-14MB	34F3077	$388
32 BIT BOARDS	4-16MB	34F3011	$448
PS/2 80-A21; A31; A61	4MB	6451060	$198
PS/2 80-041	1MB	6450375	$88
PS/2 80-111; 311; 121; 321; 081; 161	2MB	6450379	$108
ValuePoint 425SX/25/DX33 & 66	1MB	96F9290	$58
	4MB	96F9291	$268

BOCARAM/2 PLUS

For PS/2 16 Bit Memory for IBMMCA, DOS and OS2 LIM EMS 2 to 8MB (uses 1MEG SIMMS) 2MB-$239 4MB-$345 8MB-$572

IBM Laptop Memory

Thinkpad 300	2MB	33G9288	$119
	8MB	33G9289	$499
Thinkpad 700T	2MB	53G6958	$138
	4MB	53G6959	$298
	8MB	53G6960	$499
CL57SX	2MB	07G1419	$168
Thinkpad 700, 700C, 720, 720C	4MB	07G1420	$29[illegible]
	8MB	07G1421	$489
PS/Note N45	2MB	92F8804	$108
PS/2 Model N51, Notebook SLC, SX	2MB	07G1826	$108
	4MB	07G1827	$268
	8MB	07G1828	$448
Laptop N33SX, L40SX & PSNOTE 182	2MB	79F0999	$108
	4MB	79F1000	$268
L40SX, PSNOTE 182 ONLY	8MB	79F1001	$488

TOSHIBA Laptop & Notebook Memory

MODEL	MEMORY	PART#	PRICE
T1000 SE/LE/XE	2MB	PA8312U	$104
T2000 / T2000SX	2MB	PA8317U	$104
T2000SX/T1000 LE	4MB	PA8314U	$238
	8MB	PA8315U	$447
T1200XE	2MB	PA8306U	$112
T1600	2MB	PA8302U	$105
T2 SXE/T2200SX/T1800 T1850, C	2MB	PA2000U	$109
	4MB	PA2001U	$239
	8MB	PA2002U	$447
T3100	2MB	PA7135E	$178
T3100E	2MB	PA8341U	$108
T3100SX	2MB	PA8308U	$108
	4MB	PA8310U	$234
T3200 SX	2MB	PA8307U	$108
	4MB	PA8309U	$214
T3200SXC	2MB	PA8318U	$108
	4MB	PA8319U	$214
T3200	3MB	PA7137U	$186
T3300SL	2MB	PA2006U	$118
	4MB	PA2007U	$238
	6MB	PA2008U	$278
	16MB	PA2009U	$998
T4400SX, SXC, T6400 SXC, DXC	2MB	PA2003U	$125
	4MB	PA2004U	$238
	8MB	PA2005U	$448
	16MB	PA2010U	$989
	32MB		$1999
T4500, T4600, T1900C 3.3VOLTS	4MB	PA2012U	$288
	8MB	PA2013U	$478
	16MB	PA2014U	$1298
T5100	2MB	PA8301U	$104
T5200/T5200C/T8500	2MB	PA8304U	$109
	8MB	PA8313U	$448

COMPAQ Memory

MODEL	MEMORY	PART#	PRICE
Deskpro386/16	1-2MB	108069-001	$338
	2MB	108069W71	$448
	4-8MB	108070-001	$498
Deskpro 286E; 386-20; 20E; 25; 25E	1MB	113131-001	$59
	4MB	113132-001	$238
Deskpro 386S	4MB Board	113634-001	$219
	4MB Module	112534-001	$259
Deskpro386-20E; 25E	4MB	113645-001	$299
Deskpro 386/33; 386/33l; 486/25; 33L; 50L; Systempro	2MB	115144-001	$124
	8MB	116561-001	$449
	32MB	116568-001	$1999
Systempro; Deskpro	6 SKT EXP BRD W/2MB	116569-001	$399
Compaq "M"	2-64MB	129160-001	$448
Deskpro 286N; 386N; 386SX/20; 20N, Portable 486c, Deskpro M, Systempro LT Series 129160-001, Compaq ProSignio	1MB	118688-001	$49
	2MB	118689-001	$105
	4MB	118690-001	$238
	8MB	128877-001	$444
Prolina 3/25 & 25Z	2MB	141738-001	$109
	8MB	141742-001	$399
Prolina 4/25si, 4/33, 4/50	2MB Module	141683-001	$108
	4MB Module	141684-001	$238
	8MB Module	141685-001	$418
Compaq Pro Signio	16MB	149320-001	$995
	32MB	149147-001	$2395

COMPAQ Laptop & Notebook Memory

Contura 320, 325	2MB	139497-001	$108
	4MB	139498-001	$238
	8MB	139499-001	$418
Contura 4/25CX	4MB	146520-001	$228
	8MB	146521-001	$471
	16MB	146532-001	$948
SLT/286	1MB	110235-001	$79
	4MB	110237-001	$208
SLT386	1MB	118303-001	$79
	2MB	118304-001	$108
	4MB	118305-001	$238
Lte 286	1MB	117081-001	$79
	2MB	117081-002	$109
	4MB	117081-004	$238
Lte 386S/20	1MB	121125-001	$98
	4MB	121125-002	$218
Lte Lite/20, 25, 25C	2MB	129769-001	$138
	4MB	129769-002	$248
	8MB	129769-003	$421
	16MB	129769-004	$1395
LTE Lite/20 & Lite/25; 25C	16MB	N/A	$1045
LTE Lite 486/25C	4MB	142337-002	$239
	8MB	142337-003	$478
	16MB	142337-004	$1198

Simm Modules

Prices change up and down call. Sipp modules, add $3:00 ea.

DESCRIPTION	100NS	80NS	70NS	60NS	53NS	40NS
256X9	$7	$12	$15	$17		
1MEGX3		$55	$56	$61		
1MEG X 9	$44	$57	$60	$64	$69	$78
4MEG X 9		$168	$178	$188		
16MEG X 9 (36 CHIP)			$999			
256X36 1MEG (72 Pin)		$69				
512X36 2MEG (72Pin)		$114	$124	$129		
1X36 4MEG (72 Pin)		$208	$218	$288		
2X36 8MEG (72 Pin)		$418	$447	$478		
4X36 16MEG (72 Pin)		$748	$798	$848		
8X36 32MEG (72PIN)			$2150			

D-Ram Chips

DESCRIPTION	150NS	120NS	100NS	80NS	70NS	60NS
64 X 4	$1.95	$2.25	$2.45	$2.95		
256X1 STATIC				$1.95	$2.25	
256 X 1	$1.45	$1.85	$2.40	$3.00	$3.15	$3.20
256 X 4			$5.45	$6.95	$7.45	$7.95
1MEG X 1		$2.95	$4.50	$5.75	$6.45	$6.75
1MEGX1 STATIC				$4.95	$5.25	
1MEGX4				$22.00	$25.00	$29.00

CACHE MEMORY

	15ns	20ns	25ns
8KX8	5.95	5.45	4.95
32X8	9.95	8.75	
64x1	10.95	9.45	8.95
64x4	11.95	9.95	8.95
16x4	9.95	6.45	5.95
128x8		60.00	50.00

PCMCIA 2.0 SRAM MEMORY

AST POWEREXEC, DEC PALMTOP, DELL 320SLi, GRID GRIDPAD, HP 95LX, IBM PC RADIO, MOMENTA PENTOP, NCR 3125 NOTEPAD, POQET, SHARP PC3000/3100, SHARP PC-6700/6741/6781/6785, SHARP PC-6800/6841/6881/6891, ZEOS POCKET PC.

512K $98.00 1MB $148.00 2MB $284.00

Laser Printer Memory

MODULE	1MEG	2MEG	3MEG	4MEG	5MEG	8MEG
Brother HL-10V/DV		$165		$264		
Canon LBP4, 4 Lite & 4+	$118	$184				
Compaq Pagemark 15 & 20				$289		$420
Epson Action Laser II, 8000	$95	$163		$229		
Epson + 6000 and many more		$98		$168		
Fujitsu 7100 & 7200	$199	$279				
HP Deskjet 500, 500C and 550C	$59 (256K)					
HP2, 2D,		$89		$159		
3, 3D, 3P, 2P, 2P+		$113		$169		
HP LaserJet 4, 111 Si, XL300, 1200C				$218		$448
IBM Laser 4019, 4019E (3.5MB)		$129		$189		
IBM Laser 4029 All MODELS		$119		$189		
NEC90, 290		$128				
NEC95		$118				
OKI 400	$78	$98				
Packard Bell PB9500		$125		$198		
Panasonic 4410/4430		$129		$198		
Panasonic 4420/4450		$128		$198		
Panasonic 4450	$115					
Panasonic 4455		$129				
QMS 410	$119	$159		$249		
Star LS04	$129	$179		$269		
StarScript 4	$128	$178		$258		
Tosiba Page Laser 6		$99		$168		
TI XL/PS17/PS35	$48					

Major Laptop & Notebook Memory

MODEL	MEMORY	PART#	PRICE
AT&T Safari	2MB	37650	$148
	4MB	37651	$298
Bondwell B-310	1MB	23050-09100	$128
Dec pc 320 Notebook	2MB Mod	FR-PCIM-BA	$149
	4MB Mod	FR-PCIM-BB	$298
	8MB Mod	FR-PCIM-BD	$498
Dell Laptop 212, 320N; 320N+	2MB Mod	310-3204	$129
Dell 325N; NC	2MB Mod	310-3210	$139
Dell NL20 & NL25	2MB Mod	310-3213	$148
Epson NB-3 Notebook	4MB	A808511	$238
Epson NB-SL/	2MB Mod	A808771	$138
EPSON 25C Notebook	4MB Mod	A808781	$228
Everex Tempo LX, LX20	2MB	00160	$98
Everex Carrier	2MB	00263-00	$98
Grid 1500	4MB	52587	$238
Grid 1450SX	2MB	6200203	$148
Goldstar GS520, 386SX16	1MB	N/A	$98
	4MB	N/A	$298
NCR 3120 Notebook	4MB Mod	3120-K104	$299
NCR 3170 Notebook	4MB Mod	3123-K104	$399
Packard Bell, Magnavox, Mitsuba	1MB	N/A	$88
	4MB	N/A	$248
Panasonic CF170/270/370	1MB	CF-BA165	$64
Samsung Notemaster 386S	2MB	SNM002	$195
	4MB	SNM004	$395
Sanyo 17NB; 18NB & ZEOS	2MB	MBC-NBMEM2	$98
Sharp 6220	1MB	CE-621B	$98
Sharp 6640	2MB	N/A	$178
Sharp 4700MZ-200	1MB	CE-471	$198
Sharp 8501 Colorstar	2MB	N/A	$398
TI Travelmate 2000	1MB	2568034-0011	$108
TI Travelmate 3000SX; WINSX	2MB	2566996-0001	$118
TI Travelmate 4000, WINDX/25 SX/16, SX25, DX2/40	4MB	2581265-001	$279
DX2/50	16MB		$1495

AST COMPUTER Memory

MODEL#	MEMORY	PART#	PRICE
PREMMIA	4MB	501159-001	$247
	8MB	501159-002	$478
MANHATTAN SMP	16MB	501143-001	$868
BRAVO 3/25'S	2MB	500710-004	$118
	8MB	500824-002	$418
ADVANTAGE 386SX/20;25, PRO SX/25 BRAVO3/33'S	2MB	500962-001	$105
	8MB	500962-002	$434
ADVANTAGEPRO 486DX/33;SX/25, BRAVO LC4/25S; 33;33S; 500; 4'66D	2MB	500987-001	$108
	4MB	500987-002	$238
PREMIUM386/25; 33;33T; 386SX/16;20;25	1MB	500780-003	$59
	1MB	500780-002	$59
ADVANTAGE 486/25; 33;33P;SX20, BRAVO 4/33;486/25;PREMIUM 4/25; 33TE, SE 4/33	2MB	500718-004	$119
	2MB	500780-005	$119
ADVANTAGE 486/25;33;33P;SX20, POWER PREMIUM3/33,4/33;33S;50D;66D; PREMIUM386/33IE, 486/25;E;25TE;33;33TE; PREMIUM II 386/25;33, 486/33, 486SX/20 PREMIUM SERVER SE 4/33	4MB	500780-004	$228
	8MB	500780-001	$498
POWER-EXEC3/25SL, 3/25SL-C, EL	4MB		$238
	16MB		$1299
POWER-EXEC4/25SL	4MB		$248
PREMIUMEXEC286, 386SX/20;25;25C	4MB	500814-003	$228

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32Kx8	28.00	9.00	8.00	7.00
64Kx1	–	6.50	6.00	5.00
64Kx4	–	11.00	9.00	8.00
16Kx4	–	6.50	6.00	5.00
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80486	DX2-66	549.00
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80486-	SX25	109.00

Individual D-RAM Chips

MEMORY FOR IBM & APPLE

	60NS	70NS	80NS	100NS
1Megx1	7.35	7.25	6.75	4.95
1Megx4	35.00	29.00	27.00	–
1Megx4 (Zip Pack)	25.00	23.00	21.00	–
256 x 4 (Video Zip)	–	–	11.95	10.95
256x4	4.75	4.50	–	–
256 x 1	3.00	2.75	2.50	2.25
256 x 16VRAM	–	39.00	39.00	–
64x4	–	–	3.25	–
64x1	–	–	–	2.00

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SIMM MODULES (Add $5.00 for SIPP)

	40NS	53NS	60NS	70NS	80NS	100NS
1Meg x 9 (3 chip)	65.00	65.00	56.00	54.00	50.00	–
1Meg x 9 (9 chip)	68.00	68.00	65.00	63.00	58.00	44.00
4Meg x 9	–	–	160.00	175.00	179.00	–
16Meg x 9 (9 chip)	–	–	–	909.00	–	–
16Meg x 9 (36 chip)	–	–	–	899.00	–	–

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256 x 36 1Meg	–	–	65.00	59.00	–
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2 x 36 8Meg	–	479.00	459.00	399.00	–
4 x 36 16Meg	–	789.00	769.00	769.00	–
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MODEL	AMT. UPGRADED	AST PART #		PRICE
Advantage 12-386	4MegKit	500510-004		239.00
Bravo 486	4Meg	500987-002		199.00
	8Meg Kit	500987-003		398.00
	16Meg	500987-004		699.00
Premium 386/25, 16 SX	1Meg	500718-001		59.00
Premium 386/33	1Meg	500718-002		59.00
Premium II	1Meg	500780-003	WPB	59.00
386SX20, 486-25, 25E,33	4Meg	500780-004	WPB	219.00
Premium Tower, 386/33TE, 486/25TE, 486/33TE	8Meg	500780-001	WPB	438.00
Cupid Memory Board	0-32Meg	500818-001		149.00

ZENITH MEMORY MODULES

MODEL	AMT. UPGRADED	AST PART #	PRICE
Z386/33,25, 20, 33E	1Meg	ZA3800ME	59.00
Z386/33,25, 20,33E, 486/25E	4Meg	ZA3800MK	195.00
Z386SX	2Meg	Z-605-1 modules	119.00

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0-8Meg Extended and/or Expanded Memory for all IBM P/S2 Models 50, 50Z, 60, 55SX, 65SX, 16 Bit, 4.0 LIM Compat.

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IBM PS/2 SIMM MODULES

IBM PART NO.	WORKS WITH MODEL NO.	PRICE
30F5348 (512K)	30-286	37.00
30F5360 (2Meg)	30-286, 25-286, 50 MTHR BD.	129.00
33G9288 (2Meg)	Thinkpad 300.	129.00
33G9288 (8Meg)	Thinkpad300.	419.00
6450375 (1Meg)	80-041	79.00
6450379 (2Meg)	80-111, 311-121, 321, 081, 161	69.00
6451060 (4Meg)	80-A21, A-61, 80-A31, 80-111, 80-311	189.00
6450603 (1Meg)	35SX, 40SX, 55SX, Model-70's, P-70	59.00
6450604 (2Meg)	70-061, E61, 121, 50Z, 55SX, 65SX, P-70, 55LS, 65LS, X-Station 120 & 130, 35SX, 35LS, 40SX	89.00
6450608 (2Meg)	70-A21, A-61, B-21, B-61, 35SX, 35LS, 40SX Value Point325T	90.00
78X8955 (128K)	25	35.00
34F2933 (4Meg)	35SX, 40SX, 55SX, 65SX, 55LS, 65LS	199.00
87F9977 (4Meg)	55SX, 55LS, 65SX, 40SX, 35SX, 35LS	199.00
1057035 (512K)	P/S1-286	49.00
92F9935 (2Meg)	P/S1 & P/S1/386SX-2121	109.00
92F9694 (4Meg)	P/S1 & P/S1/386SX, Model-2121	209.00
6450902 (2Meg)	56, 57, 57SX, 90, 95, P-75, 57SLC Value Point77 486DX2, 486SX, SVR 85	95.00
6450128 (4Meg)	57SX, 90, 95, P-75, 57SLC, 56, 56SLC, P/S1, 386SX, Models-2123, 2133, 2155, Value Point 77 486DX2, 486SX, SVR 85	219.00
6450129 (8Meg)	35SX, 40SX	429.00
6450130 (8Meg)	56, 57, 57SX, 90, 95, P-75, 57SLC Value Point 77 486DX2, 486SX, SVR 85	459.00
79F0999 (2Meg)	LX40, N33SX, PS Note	114.00
79F1000 (4Meg)	LX40, N33SX, PS Note	219.00
79F1001 (8Meg)	LX40, N33SX, PS Note	399.00
07G1826 (2Meg	N51 (all)	109.00
07G1827 (4Meg	N51 (all)	219.00
07G1828 (8Meg	N51 (all)	449.00
07G1420 (4Meg)	CL57LSX LpTp, Thinkpad 700, 700C, 720, 720C	249.00
07G1421 (8Meg)	CL57LSX LpTp, Thinkpad 700, 700C, 720, 720C	479.00
92F8804 (2Meg)	N45SL	109.00

COMPAQ MEMORY MODULES

MODEL	AMT. UPGRADED	CMPQ PART#	PRICE
DeskPro 386/33, 386/33L,	2Meg Module	115144-001	109.00
486/25, 486/33L,	8Meg Module	116561-001	459.00
486/50L, System Pro	32Meg Module	116568-001	1599.00
DeskPro386/33L, 486/33L	(ExpBd)	116569-001	279.00
DeskPro386/25, 386/20	1Meg Module	113131-001	79.00
	4Meg Module	113132-001	229.00
DeskPro386S-16MHz	1Meg Exp Bd	113633-001	149.00
	4Meg Exp Bd	113634-001	309.00
	1Meg Module	113646-001	79.00
	4MegModule	112534-001	229.00
DeskPro 386/20E	1Meg Exp 8d	113644-001	149.00
DeskPro 386/25E	4Meg Exp Bd	113645-001	299.00
	1Meg Module	113131-001	79.00
	4Meg Module	113132-001	229.00
DeskPro 286N, 386N,	1Meg Module	118688-001	59.00
386SX/20, 386/25M, 486/33M,	2Meg Module	118689-001	89.00
486S/25M, 486S/16M	4Meg Module	118690-001	195.00
Port. 486C	8Meg Module	128877-001	429.00
M Series Exp Bd	0-64Meg	129160-001	279.00
DeskPro 386/16	1Meg Kit	108071-001	99.00
	4Meg Kit	108072-001	299.00
	1-2Meg Exp Bd	108069-001	239.00
	4-8Meg Exp Bd	108070-001	399.00
DeskPro286	512K Kit	113012-001	49.00
Prolinea386 3/25S, 3/252S	2Meg	141738-001	109.00
	8Meg	141742-001	320.00
Prolinea 486 4/25S, 4/33, 4/50, 4/66, CDS	2Meg	141683-001	95.00
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	32Meg	149147-001	1749.00

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LTE/286	2Meg Bd	117081-002	99.00
LTE/286	4Meg Bd	117081-003	204.00
LTE/386S/20	4Meg Module	121125-002	249.00
LTE LITE/20, 25, 25C	4Meg Module	129769-002	249.00
LTE LITE/20, 25, 25C	8Meg Module	129769-003	419.00
LTE LITE/20, 25, 25C	16Meg Module	129769-004	829.00
LTE LITE 4/25C	4Meg Module	142337-002	229.00
LTE LITE 4/25C	8Meg Module	142337-003	499.00
LTE LITE 4/25C	16Meg Module	142337-004	789.00
SLT/286	1Meg Module	110235-001	75.00
SLT/286	4Meg Module	110237-001	315.00
SLT/386	1Meg Module	118303-001	79.00
SLT/386	2Meg Module	118304-001	109.00
SLT/386	4Meg Module	118305-001	229.00
Contura 320, 325	2Meg	139497-001	109.00
	4Meg	139498-001	209.00
	8Meg	139499-001	419.00
Contura 4/25, 4/25C, 4/25CX	4Meg	146520-001	95.00
	8Meg	146521-001	419.00
	16Meg	146531-001	849.00

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T2000/T2000SX	2Meg	PC18-PA8317U	85.00
T2000SX/T1000LE	4Meg	PC-PA8314U	229.00
T2000SX/T1000LE	8Meg	PC14-PA8315U	429.00
T2000SXE/2200SX/T1800, 1850, C	2Meg	PC-PA2000U	85.00
T2000SXE/2200SX/T1800, 1850, C	4Meg	PC-PA2001U	229.00
T2000SXE/2200SX/T1800, 1850, C	8Meg	PC-PA2002U	429.00
T4400SX, SXC T6400	4Meg	PC-PA2004U	231.00
T4400SX, SXC T6400	8Meg	PC-PA2005U	463.00
T4400SX, SXC T6400	16Meg	PC-PA2010U	729.00
T4400SX, SXC,T6400	32Meg	N/A	2999.00
T4500, T4500C, T4600, T1900, T1900C (3.3 v)	4Meg	PC-PA2012U	259.00
T4500, T4500C, T4600, T1900, T1900C (3.3 v)	8Meg	PC-PA2013U	494.00
T4500, T4500C, T4600, T1900, T1900C (3.3 v)	16Meg	PC-PA2014U	1349.00
T4500, T4500C, T4600, T1900, T1900C (3.3 v)	32Meg	N/A	3299.00
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T3300SL	8Meg	N/A	489.00
T3300SL	16Meg	PC-PA2009U	719.00
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T1600	2Meg	PC8-PA8302U	104.00
T3100	2Meg	PC3-PA7135E	179.00
T3100e	2Meg	PC9-PA8340U	129.00
T3100SX	2Meg	PC15-PA8308U	104.00
T3100SX	4Meg	PC15-PA8310U	209.00
T3200	3Meg	PC6-PA7137U	185.00
T3200SX	2Meg	PC12-PA8307U	129.00
T3200SX	4Meg	PC12-PA8909	224.00
T3200SXC	2Meg	PC19-PA8318U	99.00
T3200SXC	4Meg	PC19-PA8319U	234.00
T5100	2Meg	PC7-PA8301U	95.00
T5200/T8500	2Meg	PC10-PA8304U	114.00
T5200/T8500	8Meg	PC10-PA8313U	459.00

NOTEBOOK, LAPTOP MEMORY

MODEL	AMT. UPGRADED	MANU. PART #	PRICE
ALR Venture	4Meg	12407980	279.00
AST Notebook Prem Exec 386SX/20/25/25L	4Meg	500814-003	209.00
AST Power Exec 3/25C, 425EL	4Meg		229.00
AST Power Exec 3/25C, 425EL	16Meg		1049.00
AST Power Exec 425SL	4Meg		239.00
AST Power Exec 425SL	16Meg		1099.00
AT&T Safari NSX/20	4Meg	PEC 37651	299.00
Bondwell B310, Plus	1Meg	23050-09100	109.00
Bondwell B310V, SX	1Meg		109.00
Bondwell B310V, SX	4Meg		229.00
Epson NB3	4Meg	A808511	219.00
Epson NB/SL 20,25,25C	2Meg	A808771	119.00
	4Meg	A808781	219.00
	8Meg		479.00
Everex Tempo LX, LX20	2Meg	PCA 00053-0001	109.00
Everex Tempo Carrier	2Meg	PWA 0884-A-J000	119.00
Goldstar GS520 386SX/16	4Meg	S386-4M	299.00
Leading Edge D/LT 386SX	1Meg		94.00
Magnavox Metalis	1Meg, 4Meg	286, 386SX	119.00,219.00
NEC Prospeed 286, 386SX-16	1Meg	PC21-21	79.00
NEC Prospeed 286, 386SX-16	4Meg	PC21-22	219.00
NEC Prospeed 386	2Meg	PC31-21	119.00
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NEC Ultralite III/SL/25C	4Meg	PC47-22	219.00
NEC Ultralite SL/20, 20P	6Meg	PC49-21	319.00
NEC Ultralite III/25C	8Meg	PC47-23	439.00
NEC Ultralite Versa	4 Meg/8Meg/16Meg		299/499/1799
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Panasonic CF170, CF270, CF370	1Meg	CF-BA165	49.00
Sanyo 17/18 NB	2Meg	MBC-NBMEM2	109.00
Sharp 6781, 6881, 6785	2Meg/4Meg		119.00/229.00
Sharp PC-6220	1Meg	CE 621B	79.00
Tandon, PC Brand, Dataworld	2Meg, 8Meg	NB386SX-20	129.00, 449.00
TI Travelmate 2000	1Meg	2568034-0001	79.00
TI Travelmate 3000	2Meg	2566996-1	84.00
TI 4000	4Meg, 16Meg		219.00, CALL
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Zenith Master Sport 386SX	2Meg	ZA-300-1	109.00
Zenith Master Sport SL, SLE	2Meg	ZA-4-4	109.00
Zenith Super Sport 286, 286E	1Meg	ZA-180-66	99.00
286E, SX	2Meg	ZA-180-64	179.00
SX Alpha	2Meg	ZA-180-86	179.00
SX Beta	2Meg	ZA-180-87	179.00
Zenith Z-Note 325L, LC	2Meg/8Meg	ZA3250-4/-5	129.00/419.00

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AMOUNT UPGRADED	OK Bd	256k	1	2	3	3.5	4	5	6	8	16	32
Canon LBP4, 4Lite, 4plus	–	–	159	219	–	–	–	–	–	–	–	–
Canon LBP-4SX	–	–	call	call	–	–	–	–	–	–	–	–
Compaq Pagemarq	–	–	–	99	–	–	195	–	–	389	–	–
Epson 6000, Action Laser	–	–	–	125	–	–	209	–	–	–	–	–
Epson Action Laser II	–	–	89	–	199	–	–	305	–	–	–	–
Epson 8000	–	–	89	–	199	–	–	305	–	–	–	–
Epson 1000	–	–	–	108	–	–	216	–	324	–	–	–
HP 2, 2D	–	–	–	119	–	–	199	–	–	–	–	
HP 3, 3D, 3P, 2P 2P+	–	–	–	109	–	–	189	–	–	–	–	–
HP 4, 4M, 4SI, 4SIMX	–	–	–	89	–	–	195	–	–	399	–	–
HP 4L	–	–	59	–	–	–	–	–	–	–	–	–
HP 3SI	–	–	69	–	–	–	199	–	–	399	–	–
HP 4SI	–	–	–	69	–	–	199	–	–	399	–	–
HPDeskjet500, 500C, 550	–	59	–	–	–	–	–	–	–	–	–	–
HPDeskjet 1200C, 1200C/P	–	–	–	89	–	–	199	–	–	399	–	–
HP Paintjet XL300	109	–	–	–	–	–	304	–	–	499	907	–
IBM Laser 4019, 4019E	–	–	–	–	–	169	–	–	–	–	–	–
IBM Laser 4029	–	–	–	–	–	–	199	–	–	–	–	–
IBM Laser 4039	–	–	–	99	–	–	199	–	–	389	–	–
NEC 90, 290	–	–	–	139	–	–	–	–	–	–	–	–
NEC95	–	–	–	99	–	–	–	–	–	–	–	–
Oki 400	–	–	–	95	–	–	–	–	–	–	–	–
Oki 400 8	–	–	135	189	–	–	–	–	–	–	–	–
Oki830, 840	–	–	–	109	–	–	–	–	–	–	–	–
Packard Bell PB 9500	–	–	–	124	–	–	209	–	–	–	–	–
Panasonic4420/4450I	–	–	–	129	–	–	209	–	–	–	–	–
Panasonic 4410/4430	–	–	–	126	–	–	195	–	–	–	–	–
Panasonic4450	–	–	99	–	–	–	–	–	–	–	–	–
TI XL/PS17/PS35	–	–	55	–	–	–	–	–	–	–	–	–

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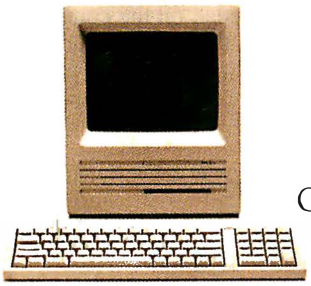
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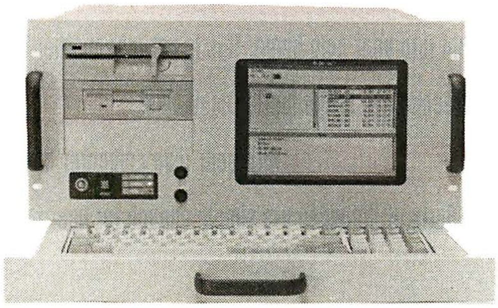
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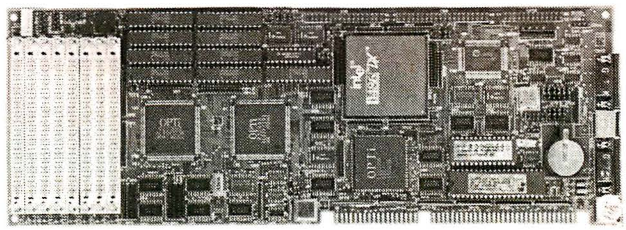
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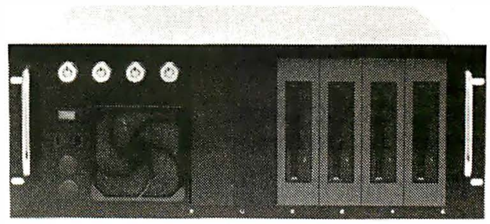
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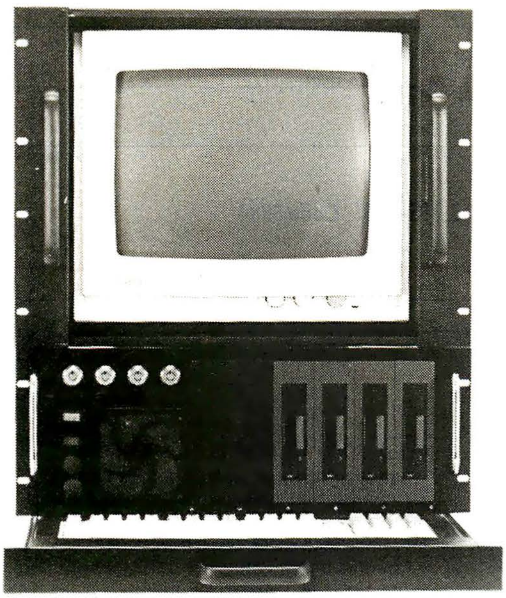


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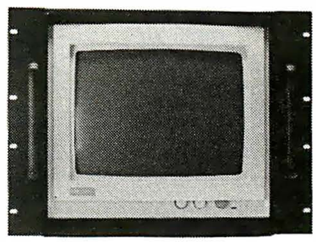
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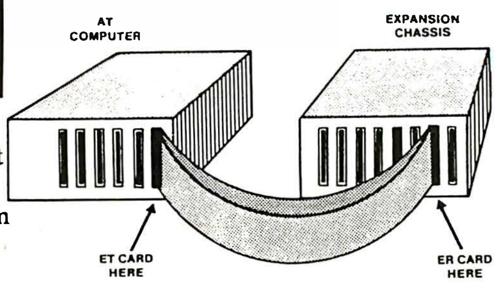
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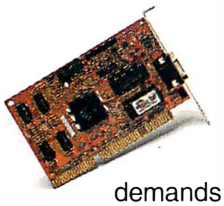
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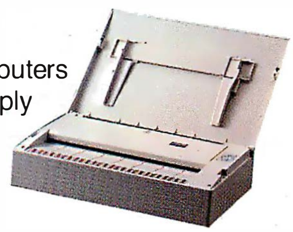






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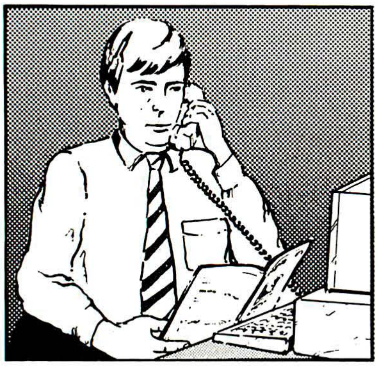
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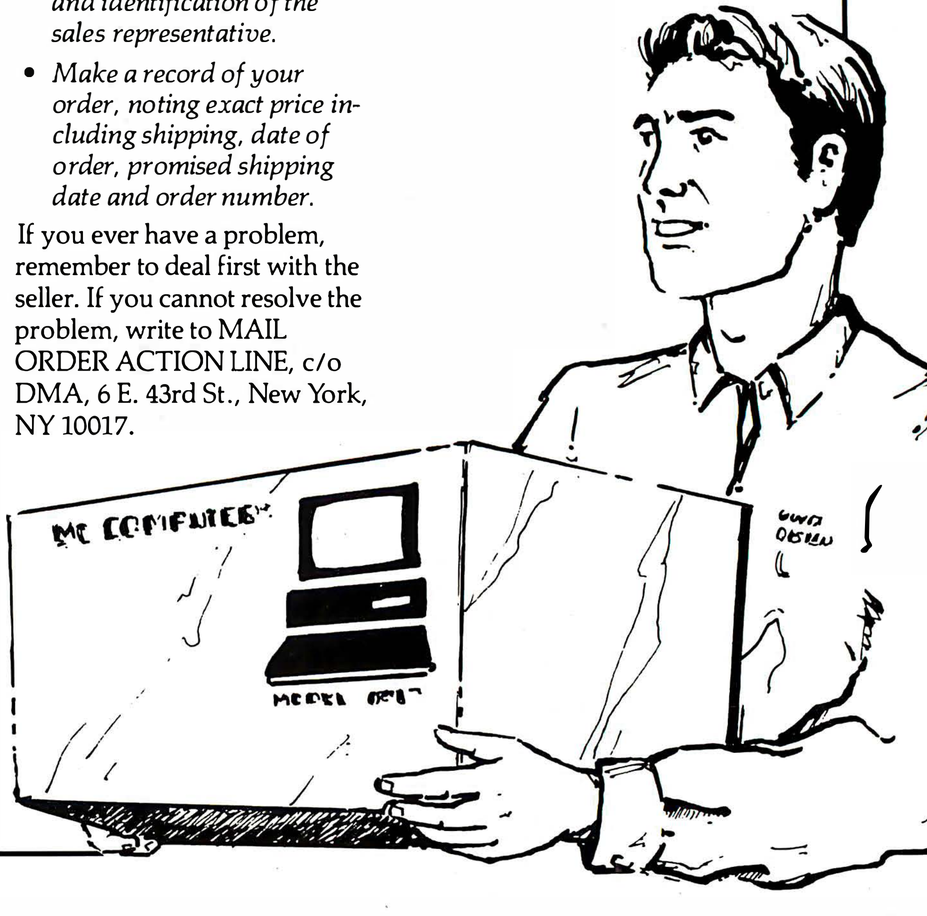
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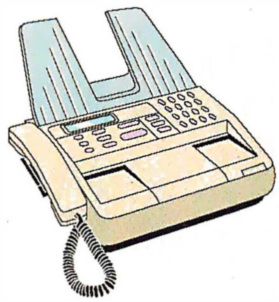
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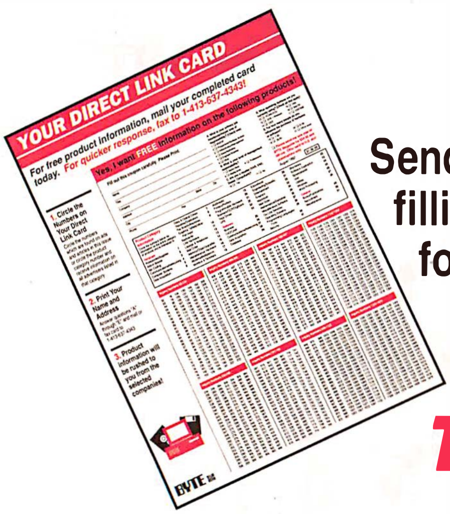
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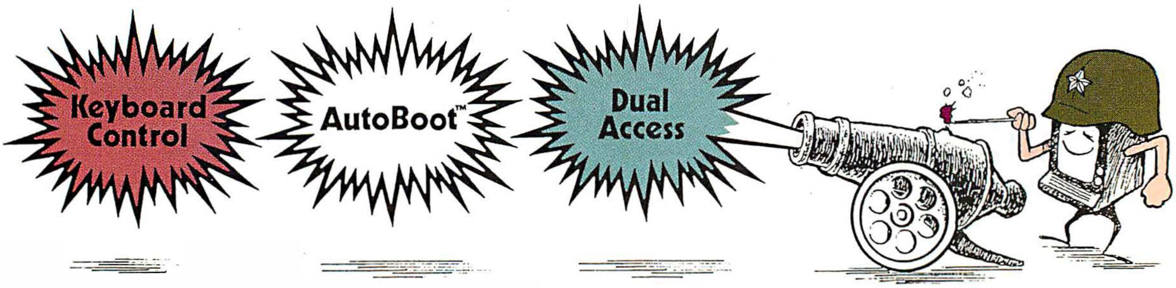
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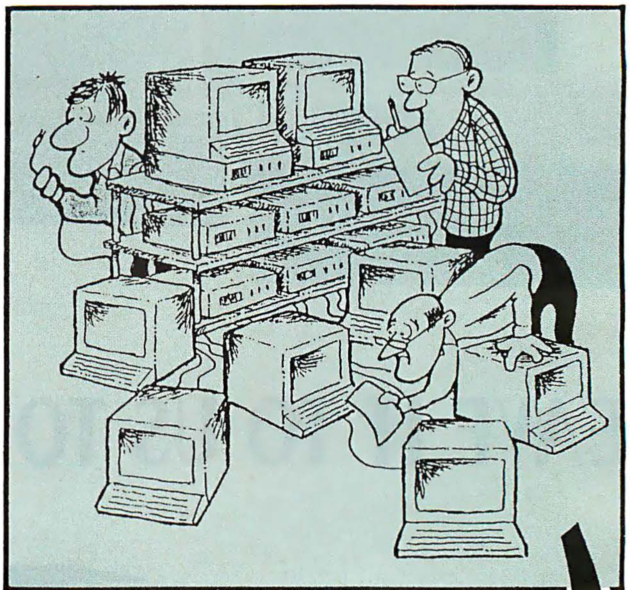
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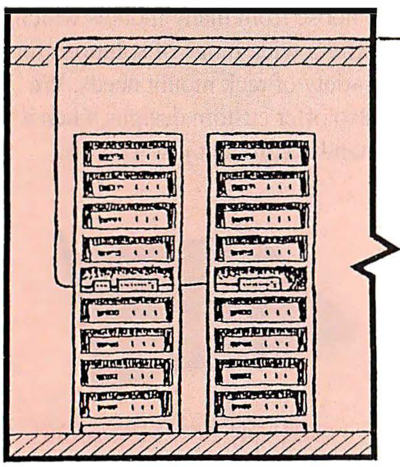
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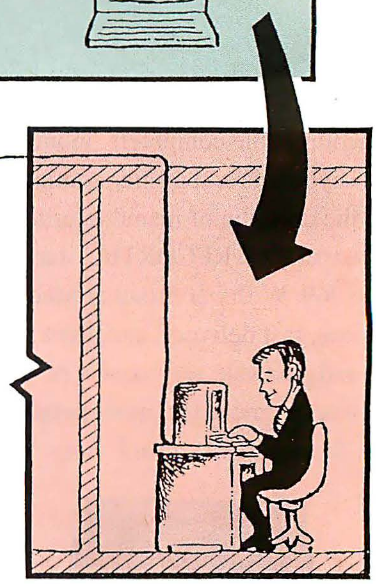




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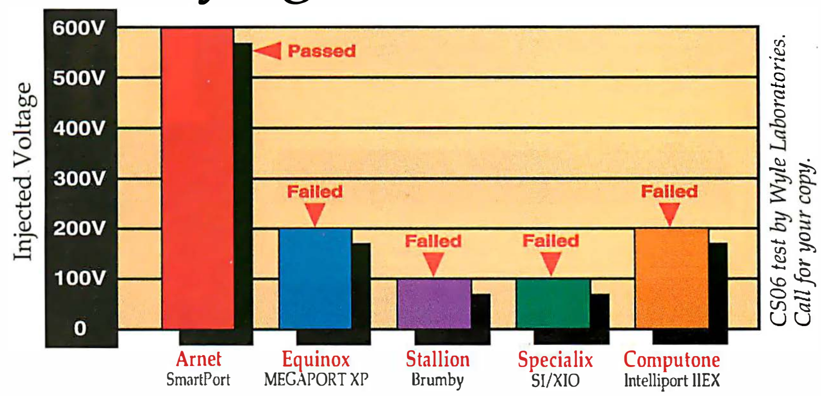
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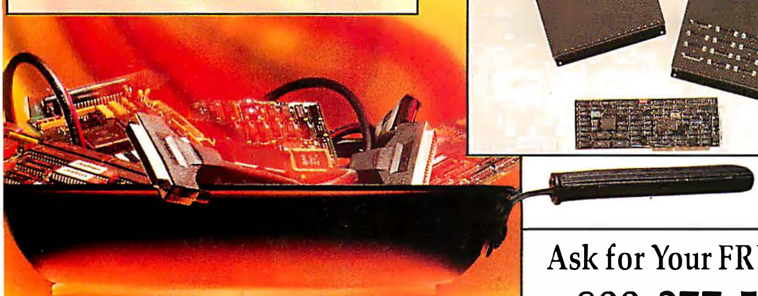
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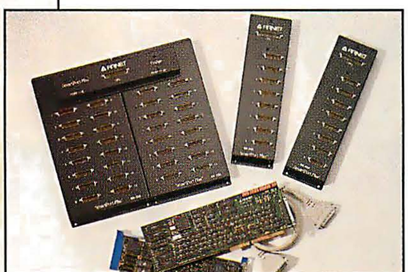
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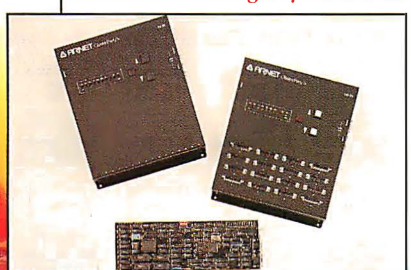
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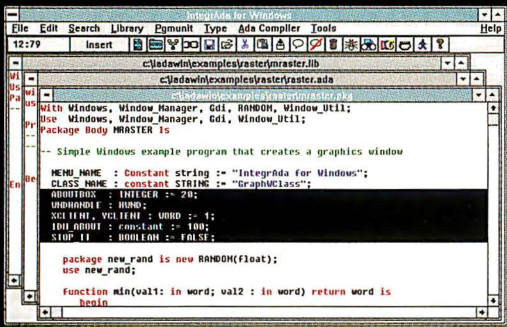
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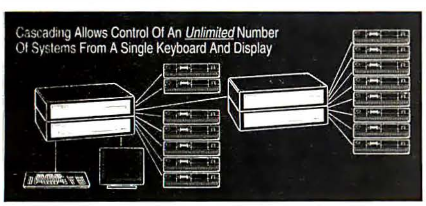
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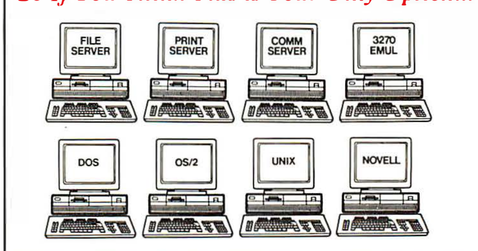
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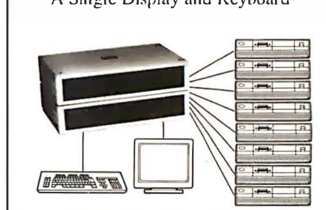
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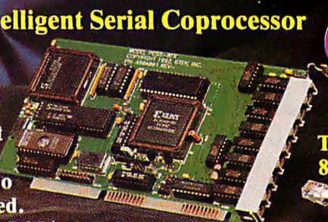
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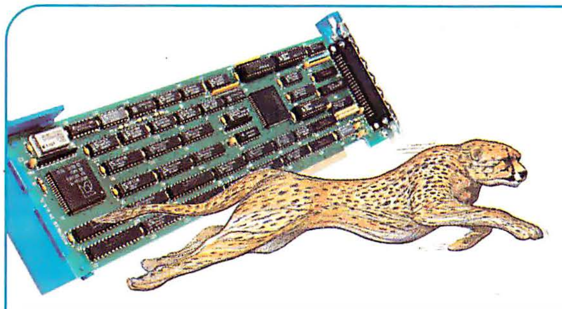
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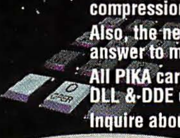
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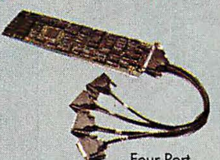
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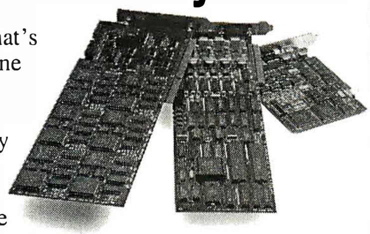
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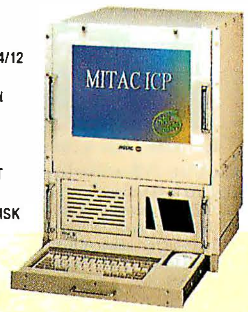
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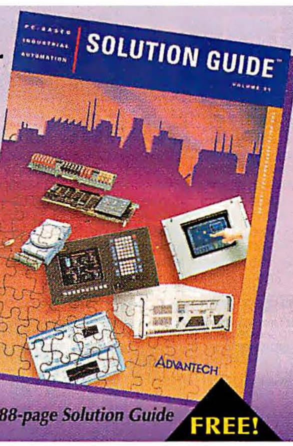
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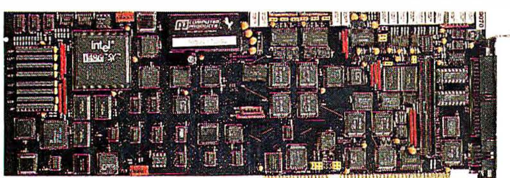
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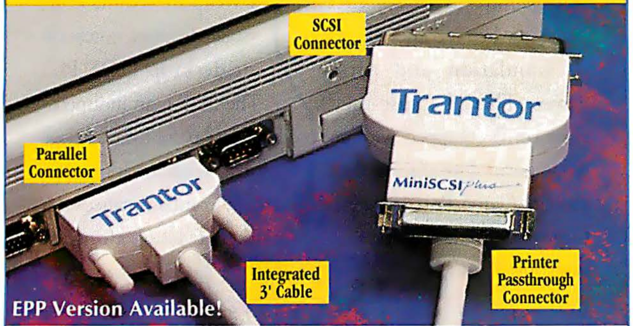
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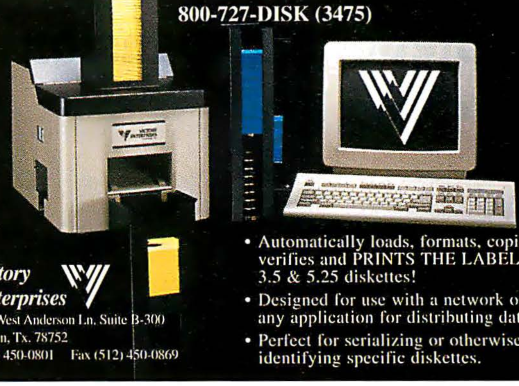
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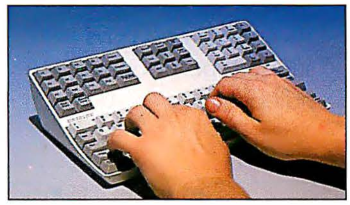
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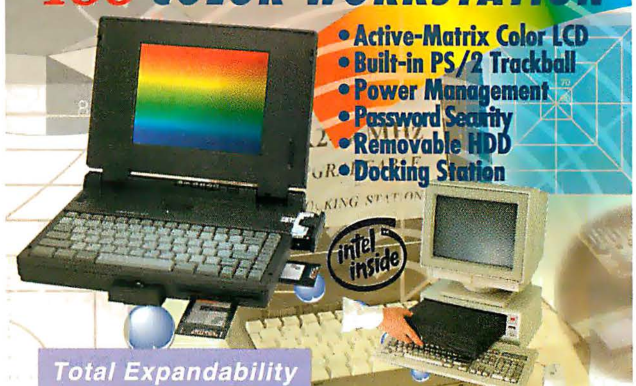
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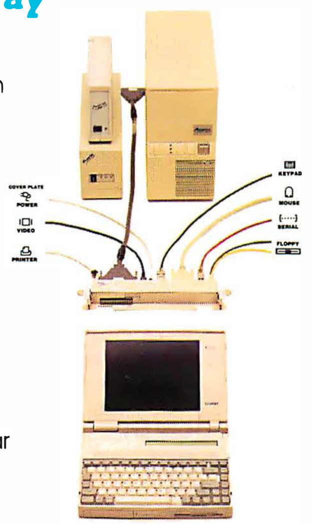
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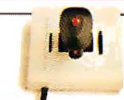


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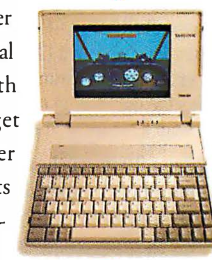
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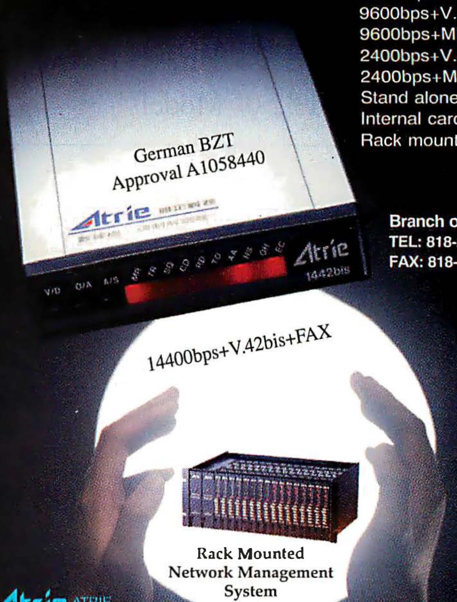
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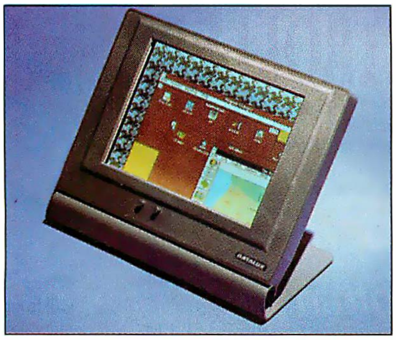
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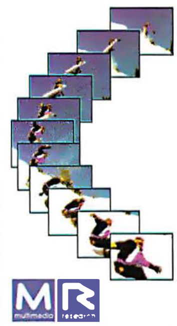
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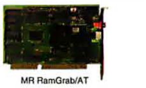
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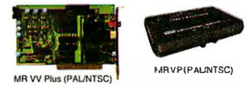
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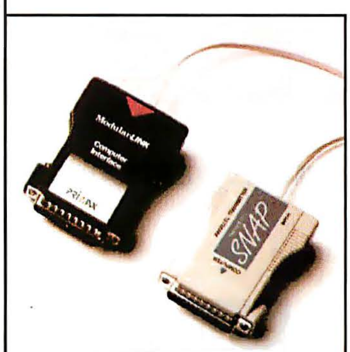
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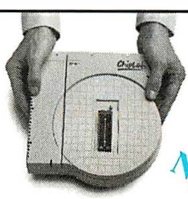
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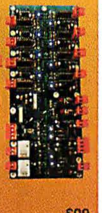
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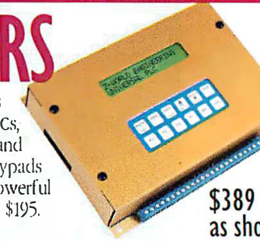
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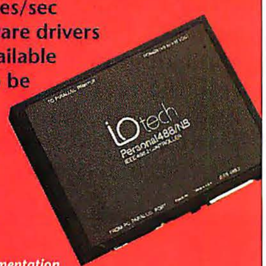
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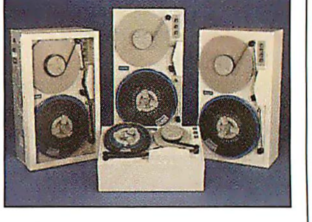
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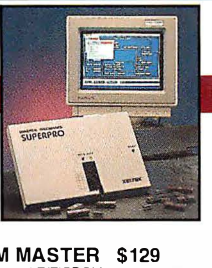
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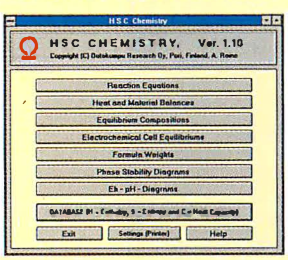
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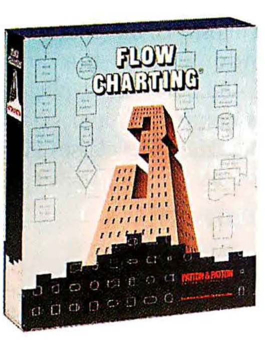
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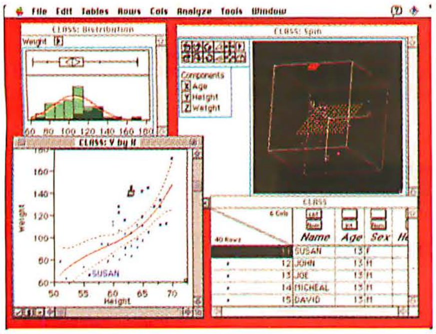
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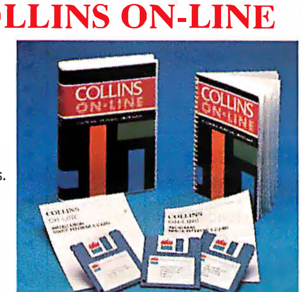
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106	MATROX VIDEO PRODUCTS GRP	256	514-685-2630
*	MCGRAW HILL BOOKSTORE	336	212-512-4100
344	MEDIA VISION (N.A.)	98A	800-845-5870
210	METATEC SYSTEMS	380	800-637-3472
200	MICRO 2000	372	800-864-8008
516	MICRO DESIGN INT'L (INT'L)	139	407-677-8333
190-191	MICRO SOLUTIONS COMP PROD	363	800-295-1214
192-193	MICRO SOLUTIONS COMP PROD	365	800-295-1214
201-202	MICRO-INTERNATIONAL, INC	362	800-967-5667
370	MICROCAL INC	201	800-969-7720
565	MICRODATA SYSTEM SRI	281	+39 1 87 988 460
308-309	MICROGRAFX	124	800-578-1981
*	MICROGRAFX	205	800-697-3540
107-108	MICROGRAFX	329	800-697-3540
310	MICROPOLIS CORP	181	800-395-3748
188-189	MICROPROSE SOFTWARE	359	800-879-PLAY
*	MICROSOFT CORP	64A-B	
*	MICROSOFT CORP	64-65	800-894-6636 ext. KS7
*	MICROSOFT CORP	95	
*	MICROSOFT CORP	119	
*	MICROSOFT CORP	137	
*	MICROSTAR LABORATORIES	384	206-453-2345
*	MICROSTAR LABORATORIES	201	206-453-2345
*	MICROWAY	182	508-746-7341
*	MICROWAY	324	508-746-4678**
525	MINICOM LTD	48IS 22	+972-2-637576**
557	MINISTRY OF INDUSTRY AND TRADE	366PC 8-9	+972-2-669-388**
517	MINOLTA GMBH (INT'L)	269	+49-511-77000
115	MINUTEMAN	59	800-238-7272
264	MITAC	383	+886-2-509-0979**
544	MITAC INT'L CORP	48IS 23	+886-2-5018231
545	MITAC INT'L CORP	48IS 25	+886-2-5018231
311	MKS / MORTICE KERN SYS	141	519-884-8861**
109	MKS / MORTICE KERN SYS	243	519-884-2251
177	MOTOROLA RISC DIVISION	36-37	
523-524	MOTOROLA UDS (INT'L)	48IS 21	+33-1-4117-4130**
531	MOXA (INT'L)	134	+886-2-910-1231**
541-542	MULTIPORT COMPUTER-SYS	48IS 16	+49-991-29017-20**

N

Inquiry No.		Page No.	Phone No.
529	NAG	48IS 32	+44-865-310139**
312-313	NANAO USA CORP	148-149	310-325-5202
232	NATIONAL INSTRUMENTS	389	800-433-3488
*	NATIONAL INSTRUMENTS	48IDRC 1-2	512-794-0100
110	NEC - SYSTEMS	296-297	800-NEC-INFO
*	NETWORK COMP DEVICES (N.A.)	227	800-800-9599
111	NEURON DATA	247	800-876-4900 ext. 637
187	NEVADA COMPUTER	364	800-654-7762
112	NORTON-LAMBERT	45	805-964-6767
113	NSTL	330	215-941-9600

O

Inquiry No.		Page No.	Phone No.
*	OBJECT MAGAZINE	48IDRC 1-2	212-274-0646**
314	OKIDATA	106	800-OKI-TEAM ext. 264
175-176	OLIVETTI (N.A.)	225	800-633-9909
173-174	OLIVETTI (N.A.)	259	800-633-9909
194	OMNICOMP GRAPHICS CORP	371	713-464-2990
527	ON TIME MKT / KARSTEN PETERSEN	48IS 32	+49-40-437472
209	ORION RESEARCH LABS	378	800-669-8088
114	OSBORNE MCGRAW-HILL	300	
270	OUTOKUMPU RESEARCH OY	390	+358 396 265310**
233	OVERLAND DATA INC	388	800-729-8725

P

Inquiry No.		Page No.	Phone No.
*	PACIFIC DATA PRODUCTS	294	619-625-3643
369	PACIFIC SOFTWORKS	201	800-541-9508
254	PACIFIC SOFTWORKS	391	800-541-9508
315	PASSPORT DESIGNS INC	191	415-726-0280
234	PATTON & PATTON	390	800-525-0082 ext. 1218
116-117	PC POWER & COOLING	63	800-722-6555
316	PERSOFT INC	145	800-368-5283
235	PERSONAL TEX	390	415-388-8853
118	PHAR LAP SOFTWARE INC	195	617-661-1510
518	PHILIPS MONITORS (INT'L)	8-9	+31-40-73-39-83**
271	PIKA TECHNOLOGIES	382	613-591-1555
119-120	PINNACLE MICRO	7	714-727-3300
121	PIONEER NEW MEDIA TECH	251	800-LASER-ON
122	PKWARE INC	72	414-354-8699
169	POET SOFTWARE (N.A.)	269	408-748-3403

YOUR DIRECT LINK CARD

For free product information, mail your completed card today. For quicker response, fax to 1-413-637-4343!

1. For FREE product information from individual advertisers, circle the corresponding inquiry numbers on Your Direct Link Card!

2. Print Your Name and Address

Answer questions "A" through "E" and mail or fax card to 1-413-637-4343.

3. Product information will be rushed to you from the selected companies!



BYTE

Yes, I want FREE information on the following products!

Fill out this coupon carefully. *Please Print.*

Name

Title

Company

Address

City State Zip

Phone Fax

A. What is your primary job function/principal area of responsibility? (Check one)
1 ❑ MIS/DIP
2 ❑ Programmer/Systems Analyst
3 ❑ Adminstration/Management
4 ❑ Sales/Marketing
5 ❑ Engineer/Scientist
6 ❑ Other

B. What is your level of management responsibility?
7 ❑ Senior-level 9 ❑ Professional
8 ❑ Middle-level

C. Are you a reseller (VAR, VAD, Dealer, Consultant)?
10 ❑ Yes 11 ❑ No

D. What operating systems are you currently using? (Check all that apply)
12 ❑ PC/MS-DOS 15 ❑ Unix
13 ❑ DOS+ Windows 16 ❑ MacOS
14 ❑ OS/2 17 ❑ VAX/VMS

E. For how many people do you influence the purchase of hardware or software?
18 ❑ 1-25 20 ❑ 51-99
19 ❑ 26-50 21 ❑ 100 or more

November 1993 *Valid until January 31, 1994* 91 96 99

Inquiry Numbers 52–238

52	53	54	55	56	57	56	59	60	61	62	63	64	65	66	67	68
69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85
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Inquiry Numbers 239–425

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Inquiry Numbers 426–612

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Inquiry Numbers 613–799

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Inquiry Numbers 800–986

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Inquiry Numbers 987–1151

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Inquiry Numbers 1152–1316

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Inquiry Numbers 1317–1481

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1467	1468	1469	1470	1471	1472	1473	1474	1475	1476	1477	1478	1479	1480	1481

Product Category Information

Circle the numbers below for additional information on the products you're interested in.

Hardware

Accessories/Supplies 1
Add-in Boards 2
Bar Coding 3
Communications/Networking 4
Computer Systems 5
Data Acquisition 6
Disks & Optical Drives 7
Diskettes/Duplicators 8
Fax Boards/Machines 9
Graphics Tablets/Mice/ Pen Input 10
Keyboards 11
LAN Hardware 12
Laptops & Notebooks 13
Mail Order 14
Memory/Chips/Upgrades 15
Miscellaneous Hardware 16
Modems/Multiplexors 17
Monitors & Terminals 18
Multimedia 19
Printers/Plotters 20
Programmable Hardware 21
Scanners/OCR/Digitizers 22
Tape Drives 23
UPS 24

Software

Business 25
CAD/CAM 26
Communications/Networking 27
Data Acquisition 28
Database 29
Educational 30
Engineering/Scientific 31
Entertainment 32
Graphics 33
Macintosh 34
Mail Order 35
Mathematical/Statistical 36
Miscellaneous Software 37
On-Line Services 38
Operating Systems 39
Programming Languages/ Tools 40
Security 41
Shareware 42
Software Duplication 43
Spreadsheets 44
Unix 45
Utilities 46
Windows 47
Word Processing 48

General

Books/Publications 49
Recruitment 50
Miscellaneous 51

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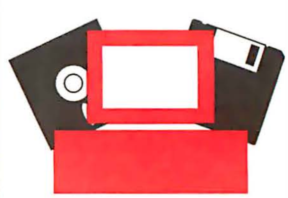
See reverse side for card.

1. For FREE product information from individual advertisers, circle the corresponding inquiry numbers on Your Direct Link Card!

2. Print Your Name and Address

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BUSINESS REPLY MAIL

FIRST CLASS MAIL PERMIT NO. 176 PITTSFIELD, MA

POSTAGE WILL BE PAID BY ADDRESSEE

BYTE

READER SERVICE
P.O. BOX 5110
Pittsfield, MA 01203-9460
USA

NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

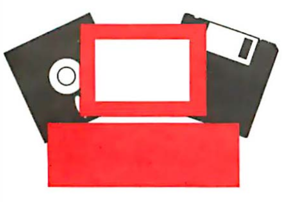
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BYTE

Yes, I want FREE information on the following products!

Fill out this coupon carefully. *Please Print.*

Name ______________________________

Title ______________________________

Company ______________________________

Address ______________________________

City ______________ State ______ Zip ______

Phone ______________ Fax ______________

A. What is your primary job function/principal area of responsibility? (Check one)
1 ❑ MIS/DP
2 ❑ Programmer/Systems Analyst
3 ❑ Adminstration/Management
4 ❑ Sales/Marketing
5 ❑ Engineer/Scientist
6 ❑ Other

B. What is your level of management responsibility?
7 ❑ Senior-level
8 ❑ Middle-level
9 ❑ Professional

C. Are you a reseller (VAR, VAD, Dealer, Consultant)?
10 ❑ Yes
11 ❑ No

D. What operating systems are you currently using? (Check all that apply)
12 ❑ PC/MS-DOS
13 ❑ DOS + Windows
14 ❑ OS/2
15 ❑ Unix
16 ❑ MacOS
17 ❑ VAX/VMS

E. For how many people do you influence the purchase of hardware or software?
18 ❑ 1-25
19 ❑ 26-50
20 ❑ 51-99
21 ❑ 100 or more

November 1993 *Valid until January 31, 1994* 91 96 99

Inquiry Numbers 52–238

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69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85
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Inquiry Numbers 239–425

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Inquiry Numbers 426–612

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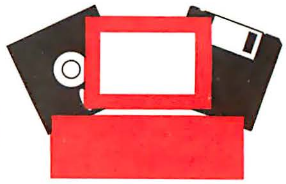
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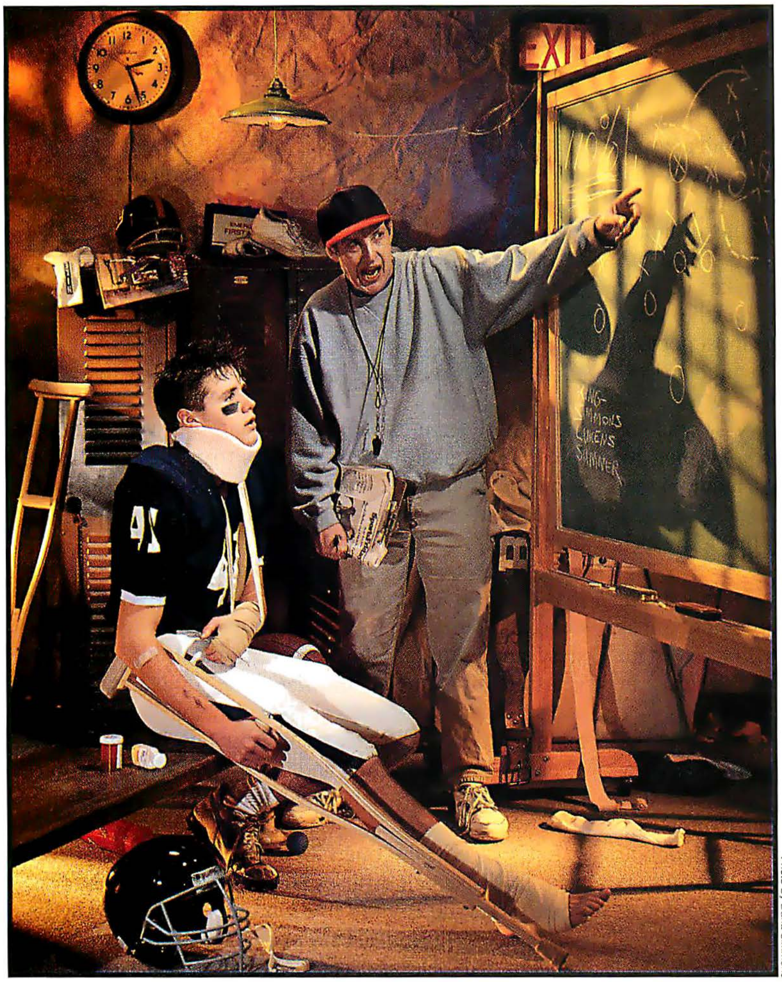


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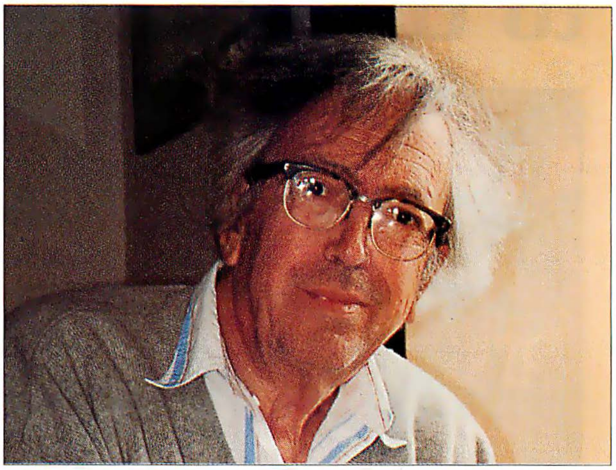
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Commentary Hugh Kenner

Electronic Books

Quick, someone please tell all those CD-ROM publishers that most books are better left on paper



MARY ANNE KENNER © 1993

The custodians of any new medium are subject to panic attacks. *Here it is. Now what do we (shudder!) do with it?* The typical answer is, recycle the offerings of a previous medium.

So the early-1930's talkies offered remakes of *Tom Sawyer* and *A Midsummer Night's Dream*, the latter hyped as the longest talkie ever made. The most popular available comedian, Joe E. Brown, was featured as Bottom the weaver; and do I misremember, or wasn't the young Mickey Rooney also featured? Anyway, you see the idea: The medium had to be made respectable, by having its best talents hype the content of a medium that was earlier, hence prestigious. Decades later, TV would likewise be legitimizing itself, by showing movies, which with its aid became "cinema."

And in the 1990s here's, ugh, the CD-ROM medium, and what the flacks are doing with that is promoting it as a neat repackager of books. Books! Books!! Jane Austen: The Complete Illustrated Novels on CD-ROM. How can I contain my excitement?

Easily. First of all, if I'm planning to browse the 60,000-odd words of her *Emma*, which will take a few hours, it's a lot more comfortable to sit this way and that way, holding a small book in one hand, than to prop myself erect while the clock ticks, in front of an immobile screen. Next, I've really no immediate use for the software that can tell me *Emma* uses the word *the* 1479 times, *marriage* 33 times, *drawing-room* 15 times, *Christian* a mere twice.

Granted, that diminuendo is amusing; granted also, word-frequency studies came in the 1930s and quickly went because hand-counting was simply unthinkable. But now that we control the data, isn't there reason for a revival? Miles Hanley and some students at the University of Minnesota used mere cards late in the 1930s to gather statistics on James Joyce's *Ulysses* that greatly aided Harvard's George Kingsley Zipf with Zipf's Law....

Sorry, am I getting ahead of you? Zipf's Law, one of the intellectual curiosities of this century: From the principle that you'd tend to place nearby the tools you'd use most often, Zipf derived a linear connection between frequency-of-use and usefulness. The commonest word in *Ulysses* (*the*) occurs 15,000 times; there are 15,000 words that occur once. You glimpse the principle; the third commonest word occurs about as often as the words that occur three times. The subject was never followed up, for two reasons: (1) Before computers, data such as what the Hanley team had turned up simply wasn't accessible; (2) Zipf absolved all skeptics from any need to respond by dying just after his big book was published. (Five decades later, you can still hear the collective sigh of relief.)

So there's work still to be done on Zipf's Law, but that's not what the Great Literature CD-ROM has in mind. It offers "The Full Text of Over 500 Literary Classics," including an abominable translation, some 150 years old, of Dante's *Commedia*, the rights to which, of course, cost the publishers absolutely nothing, which is the main reason such dreary junk shows up in collections. There's also "full search and browse ability," but, Lord, how'd you begin to guess what to search for? Or use what you've found.

Let's face it, the one CD-ROM I've met that has a need for its search utilities is The Oxford English Dictionary, Second Edition, the whole 20 volumes. Dictionaries, by definition, are for searching. Alas, the printed versions will search on only one alphabet (word). But how often does OED-2 cite T. S. Eliot? The CD-ROM is quick to tell us: exactly 555 times. It will also display the citations, though more creakily than you'd like. And how many quotations, pray tell, from *Finnegans Wake*? Glad you asked: 185. Something meant to be consulted in-and-out is perfect for CD-ROM access; a dozen search indexes supplant the sole one permitted by print.

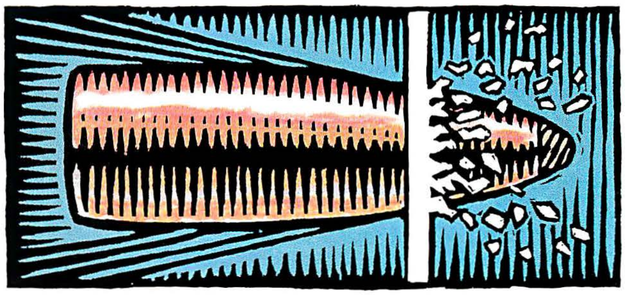
If you want to resume work on Zipf's Law, then welcome all those CD-ROM texts (which include *Jurassic Park*). Otherwise, just settle for the OED-2, which I find I use every day. The computerization is primitive—you can't, for instance, easily print your findings—but Oxford did understand what computers do best with books, which is not display them for reading. ■

Hugh Kenner is Franklin and Callaway Professor of English at the University of Georgia. He writes for publications ranging from the New York Times *to* Art & Antiques. *You can contact him on BIX as "hkenner."*

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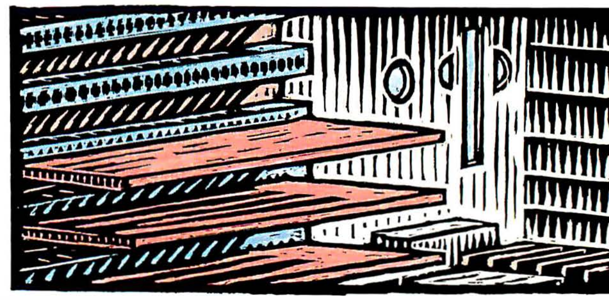
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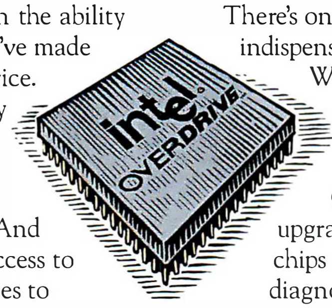
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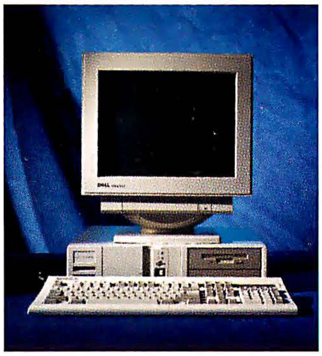
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